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The Caribbean Forester

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U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TROPICAL FOREST RESEARCH CENTER
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Caribbean Forester

El "Caribbean Forester", revista que el Servicio Forestal del Departamento de Agricultura de los Estados Unidos comenzó a publicarse en julio de 1938 se distribuye semestralmente sin costo alguno y está dedicada a encauzar la mejor ordenación de los recursos forestales de la región del Caribe. Su propósito es estrechar las relaciones que existen entre los científicos interesados en la Ciencia Forestal y ciencias afines encarándoles con los problemas confrontados, las políticas forestales vigentes y el trabajo que se viene haciendo para lograr ese objetivo técnico

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The "Caribbean Forester", published since July 1938 by the Forest Service, U. S. Department of Agriculture, is a free semiannual journal devoted to the encouragement of improved management of the forest resources of the Caribbean region by keeping students of forestry and allied sciences in touch with the specific problems faced, the policies in effect, and the work being done toward this end throughout the region.

Contributions of not more than 20 typewritten pages in length are solicited. They should be submitted in the author's native tongue, and should include the author's title or position and a short summary. Papers should be sent to the Leader, Tropical Forest Research Center, Río Piedras, Puerto Rico.

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Le "Caribbean Forester", qui a été publié depuis Juliet 1938 par le Service Forestier du Département de l'Agriculture des Etats-Unis, est une revue semestriele gratuite, dediée a encourager l'aménagement rationnel des forêts de la region caraïbe. Son but est d'entretenir des relations scientifiques entre ceux qui s'interéssent aux Sciences Forestières, ses problemès et ses méthodes les plus récentes, ainsi qu'aux travaux effectués pour réaliser cet objectif d'amelioration technique.

On accept voluntiers des contribution ne dépassant pas 20 pages dactilographiées. Elles doivent ètre écrites dans la langue maternelle de l'auteur qui voudra bien préciser son titre ou sa position professionnelle et en les accompagnant d'un résumé de l'étude. Les articles doivent ètre addressés au Leader, Tropical Forest Research Center, Río Piedras, Puerto Rico.

La revue laisse aux auteurs la responsibilité de leurs articles. La reproduction est permise si l'on présice l'origine.

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Seventeenth Annual Report

TROPICAL FOREST RESEARCH CENTER

Puerto Rico

The year 1956 saw progress in each of the two main lines of research at the Center: forest management and forest products utilization. The major project in forest management research concerned the inauguration of pilot demonstration management in the Luquillo Experimental Forest. In the field of forest products utilization the machining tests of 62 local woods were completed and plans were drawn up for a formal program of research on wood preservation.

Other research projects which were continued from previous years include the studies of artificial forest regeneration in both Puerto Rico and the Virgin Islands, and investigations of tree growth as affected by environmental factors and silvicultural treatment. Some 160 studies of this character were inspected or measured during the year. Of these, 38 were terminated and 27 new studies were begun during the year. The collection of soil trafficability data for the Waterways Experiment Station was completed except for a few remaining weather and soil moisture records.

Directly related to the research work were a number of other accomplishments during the year. The cooperative forestry program was strengthened both in Puerto Rico and in the Virgin Islands. A new cooperative program with the Commonwealth government was inaugurated which provides for a Service Forester to offer direct technical assistance for reforestation of private lands within a concentrated area of critical watershed lands. The Center not only assisted in the training of the Service Forester but shared under the Clarke-McNary Act with the Commonwealth the costs of planting stock production for this purpose and made 15 demonstration woodlot and roadside plantings outside of the area of concentration.

Another outgrowth of the Center's research work, the program of training foreign students in tropical forestry, was continued during the year. In all, 20 such students from 11 countries spent an aggregate total of 36 man-months at the Center. The main activity of this nature was the spring training course held for 14 students from March 7 to May 18. This course was broad, covering all aspects of forestry. The entire staff participated in the instruction, and cooperative assistance was obtained from the Food and Agriculture Organization of the United Nations and from many local governmental agencies concerned with related problems.

In the Virgin Islands the forestry program carried out in cooperation with the Virgin Islands Corporation succeeded in establishing four forest plantations, three on private lands and one on the Thomas Estate Demonstration Forest. These plantations, including both teak and mahogany, covered about 20 acres.

The proclamation of the 26,000-acre Luquillo Division of the Caribbean National Forest as the Luquillo Experimental Forest led to a study of the resources of this area and the most desirable policies for administering their use. Protection was improved by fencing of critical boundaries and systematized patrol. Numerous tracts adjacent to the forest were located as a part of a land exchange with the Commonwealth which would enlarge the Luquillo Forest in trade for the Toro Negro Forest. This transaction is now primarily a matter for the Commonwealth to complete, purchasing the tracts offered and transferring title to the Federal Government. Progress was made in the betterment and surfacing of

11.2 miles of roads within the Forest under a contract with the Commonwealth government. Advice was offered to the Commonwealth Parks and Recreation Administration for the betterment of the La Mina Recreational Area within the Forest. The administration of more than 100 permitted special land uses within the forest has continued. Included are some 27 subsistence agricultural parcels where the Center has advised the permittees as regards land use and cropping practices.

The training of the personnel of the Center received more attention in 1956 than in previous years. The Center Leader spent 4 months of the year in the United States becoming better acquainted with research administration at Washington and at the Southern Forest Experiment Station. The Forest Products Utilization Project Leader attended the annual planning conference of the Forest Products Laboratory at Madison. Staff members attended the spring training course sessions led by outside specialists which were of especial value to them. Particularly important here were the sessions on forest nurseries and planting, interpretation of aerial photographs, and forest policy and administration.

The progress of the Center in 1956 has to a considerable measure been a result of cooperative assistance by other agencies. Assistance received from the Office of the Chief, from the Southern Station, and from the Forest Products Laboratory has made possible a more effective program at the Center both through better administration and through better planned technical work. The Division of Forests, Fisheries, and Wildlife of the Commonwealth continued to make available protected public forest areas and nursery assistance for forest management investigations. The Virgin Islands Corporation financed more than half of the cost of the research in progress on St. Croix. The Virgin Islands Experiment Station, through provision for office and nursery facilities, was also of material assistance to the work at that location.

FOREST MANAGEMENT RESEARCH

The chief field of investigation at the Center has always been forest management. The Center was handicapped in 1956 because of the vacancy throughout the year of the forest management project leader position and because of the absence of the Center Leader during half of the year. Progress reported here, to a large measure, reflects maintenance work on studies begun previously. Exceptions are the studies of hurricane damage and of regeneration in the Virgin Islands. The most important results of the research are described in detail at the time of publication. Only a few of the highlights are presented here.

Hurricane Damage

The hurricane of August 12, the first to pass directly over the island since 1932, provided also the first opportunity to study extreme wind effects upon improved forest stands and plantations. This hurricane passed over the island, from southeast to northwest, and affected the entire island, but as a hurricane it was not large. Wind records at two locations were 92 and 115 miles per hour. Rainfall was unusually light for a hurricane, generally less than 6 inches for the period of the storm.

A survey of the effects on experiments in progress and on forests in general was undertaken during the weeks immediately following the storm. A report on this survey is in preparation for publication. The general conclusions are the following:

1. Severe hurricane damage to forests, that is, complete or nearly complete blowdown, was limited almost entirely to areas within 5 miles of the path of the storm center. As distance from the path increased the severity of the damage declined sharply.
2. The severity of the hurricane damage to the forests was inconsistent within short distances. Severely damaged stands

were found adjacent to unaffected stands of similar composition and structure and in supposedly similar topographic locations.

3. Mixed, all-aged natural stands suffered generally less hurricane damage than plantations.
4. Damage was more severe in thinned than in unthinned stands.
5. Broadleaf mahogany, *Swietenia macrophylla* King, showed again its susceptibility to windthrow on heavy clay soils, this characteristic having been observed as a result of a storm 2 years ago.
6. Twenty-year-old eucalyptus (*Eucalyptus robusta* J. E. Smith) suffered top breakage mostly, while 18-year-old teak (*Tectona grandis* L.) was uprooted and broken off to almost an equal degree. Both species of ages shown suffered 95 percent or more damage in the direct path of the hurricane.

Only a few of the regeneration and growth experiments of the Center were affected by the hurricane. These were located in the Aguirre, Carite, and Rio Abajo Forests.

Regeneration

The results of the regeneration studies reported here concern primarily the adaptation of tree species to different sites. For this reason they are presented according to these sites, each of which makes up an important area of forest land.

Shallow Loam Soils

Mexican cypress (*Cupressus lusitanica* Mill) continues to be one of the most spectacular planted trees on rocky shallow loam soils at high elevation. Observations made in a 6-year-old plantation at 3,500 feet elevation (precipitation 120 inches annually) in the Toro Negro Forest show this species superior even to eucalyptus in growth. Its rapid growth rate plus the potential utility of its wood make this species one of the most promising introductions yet made in Puerto Rico. The trees in this planting average 5 inches d.b.h. and 25 feet in height, with a maximum of 11 inches and 35 feet. Their form is excellent and their dense crowns have shaded out competing vegetation. Naturally established seedlings have begun to appear beneath the plantation. This plantation was not hit by the 1956 hurricane, but the lack of windfirmess characteristic at low elevation and on deep wet clays is not evident on this rocky site. Additional plantings are proposed for 1957.

Deep Lateritic Clay Soils

Maga (*Montezuma speciosissima* Sessé & Moc.), an endemic tree species which produces a termite-resistant cabinet wood, has finally been dropped from the research programs, after more than 20 years of efforts to produce it. The tree is not difficult to regenerate, although the seed is very perishable, but other superior species have proven equally adaptable to its sites. Below 1,000 feet elevation, where maga occurs naturally, it is inferior to broadleaf mahogany, *Swietenia macrophylla* King, both in growth rate and in form. Under these conditions maga typically declines in diameter growth rate after the trees reach 3 or 4 inches d. b. h. At that stage the trees also put forth a large number of sprouts from the stem, and thus lose their initial good form.

Maga on deep lateritic clay soil at 2,500 feet elevation in the Toro Negro forest (precipitation 98 inches annually) has retained its good form. Its diameter growth, while slower than at lower elevation, has been accepted as satisfactory, since no superior species has been known. Now, however, after 20 years, the trees, with an average diameter of 5 inches, and a height of 30 feet, have virtually stopped growing, the crowns have become thin, and many have died from what appears to be a root rot. At the same time

adjacent tests of mahoe (*Hibiscus tiliaceus* L.) have shown this species, which produces a timber of at least equal value, to grow much more rapidly, trees attaining a diameter of 6 inches and a height of 65 feet in 10 years.

The prospects for bamboo production on deep lateric clays in the mountainous interior of the island have become further clarified by reexamination of a 10-year-old test planting at 3,200 feet elevation (precipitation 110 inches annually) in the Toro Negro Forest. Three species: *Bambusa tulda* Roxb., *B. longispiculata* Gamble ex Brandis, and *B. textilis* McClure were used. The first two are suited for furniture and are outstanding in resistance to powderpost beetles. B. *textilis*, relatively thin-walled, is useful for baskets and similar articles. Four planting spacings were used, 10 x 10, 15 x 15, 20 x 20, and 25 x 25 feet.

Width of spacing has been significant to date only as regards rapidity of domination of the site by the bamboo. On the more degraded slopes a spacing of 10 to 15 feet is indicated, particularly with the smallest species, *B. textiles*. With wider spacings weeding was necessary into the third year. On the lower slopes and other more protected sites 25-foot spacing seems adequate for early control of vegetation. Nothing can be concluded yet as to the relative productivity of these different spacings, since intense competition among the plants is only beginning.

At the end of 10 years the *B. tulda* clumps range from 30 to 45 feet in height and have about 40 culms per clump. *B. longispiculata* has developed more slowly, averaging 20 to 25 feet in height. On the slopes the plants are chlorotic and still do not dominate competing vegetation. They average about 40 culms per clump. *B. textilis* ranges from 30 to 35 feet in height and has produced more than 100 culms per clump. Future observations will provide a conclusive comparison between species and spacings in terms of lineal feet of culm per unit of land area.

Additional bamboo tests are proposed for shallow loam soils for possible production of cellulose.

Deep Granitic Loam Soils

Almendrón (*Prunus occidentalis* Sw.), previously reported as promising as an underplanted tree on deep granitic loam soil at 1,800 feet elevation (precipitation 150 inches annually) in the Luquillo Montains, has continued to develop very satisfactorily. A 10-year-old underplanting which has been periodically released has produced trees of 2 to 4 inches in diameter and from 20 to 65 feet in height. This species, a native to Puerto Rico, produces a termite-resistant timber prized for cabinetwork. Its development on this site is better than that of other species tested.

Laterite Soils

Mexican cypress (*Cupressus lusitanica* Mill) shows promise for the reforestation of the laterite soils at an elevation of about 1,500 feet (annual precipitation 110 inches). A 4-year-old test planting in the Maricao forest on a site where many species of eucalyptus have failed has produced vigorous trees 5 to 8 feet tall. The growth rate of these trees is not as rapid as elsewhere in the island, but one favorable result is that the limbs are more rigid and make the trees well suited for Christmas trees. Additional plantings have been recommended for this purpose.

Mycorrhiza inoculation of pines on laterite soil, reported without conclusive results last year, has continued under observation. The species treated was slash pine (*P. elliottii Engelm.*). The seedlings had already been outplanted and had become chlorotic. Previous application of calcium superphosphate as a result of soil tests proved unfruitful. The inoculating material was humus and A-horizon soil from shortleaf and longleaf forests in the United States. About 330 cc. of material was worked into the soil around the stem of 23 trees, with 24 alternate trees as checks.

After 9 months the treated seedlings had recovered in color of foliage and mycorrhiza were apparent on the roots. The checks were unchanged in appearance, and no mycorrhiza were found. After 2 years the treated seedlings averaged 2.5 feet in height and continued to show a deep green color, compared with chlorotic check trees, still chlorotic and 1.5 feet in height, about the same size as when planted. It now seems conclusive that the mycorrhiza are a prerequisite to the introduction of slash pine on this area. Additional tests will be made to determine whether the inoculated soil can now serve to inoculate nursery beds and other planted trees.

Rocky Slopes on St. Croix

Experiments directed toward the simplification of regeneration of West Indian mahogany (*Swietenia mahagoni* Jacq.) and broadleaf mahogany (*Swietenia macrophylla* King) on the island of St. Croix, begun on a formal basis in 1955, were replicated and expanded in 1956 to include 5 sites, 2 species, 3 seasons, 9 types of planting material, and a total of nearly 12,000 trees or seed spots.

The need to repeat tests for several years has become apparent in the inconsistencies in the results of experiments to date. This is largely due to the variability of the climate, with brief but severe droughts possible any time during the first half of the normally rainy part of the year, from May to September. In favorable years this is the best time to plant because it is followed by three rainy months: October, November, and December, before the normal dry period begins. Planting in these three rainy months is hazardous because the trees may have insufficient time to develop adequately to withstand the subsequent drought.

The most reliable method to regenerate mahogany under these conditions has proven to be the planting of vigorous stock about 18 inches tall with a ball of earth (tar-paper pots). This is as true in the rainy mountains (45 to 60 inches of precipitation) with broadleaf mahogany as it is in the drier coastal hills (25 to 45 inches precipitation) with West Indian mahogany. Accordingly this is the practice generally being followed in the planting program directed by the Research Center for the Virgin Islands Corporation. Nevertheless, costs of planting stock and planting with this method are high, so studies of direct sowing and the planting of bare-rooted stock have been undertaken.

In the humid zone tests have concentrated on broadleaf mahogany, the most rapid growing species. Plantings of bare-rooted stock made in the early fall of 1955 showed that with vigorous planting stock survival can be satisfactory on the best sites. Accordingly, this practice will be used in the forestry program in 1957. Direct seeding of this species on this site is also promising as regards survival. Sowings made during July, August, and September 1956 showed a survival of 80 to 100 percent of the spots (sown 10 seeds to the spot) at the end of the year. The seedlings were vigorous and about 6 inches tall. This method of regeneration, although far cheaper than planting, entails a longer period of plantation care and should not be used generally until its relative economy has been determined. In the meantime the survival of the seedlings through the coming dry season must be determined.

In the drier zone both species have been tested. Well developed, potted stock of both species survives planting well in favorable years. Bare-rooted stock has survived well only in especially favorable years and on the more humid sites. Direct seeding in this zone has been generally unsuccessful except where both the site and the weather are specially favorable. The seedlings, particularly those of West Indian mahogany, remain small and delicate for about a year, requiring special protection. Tests are continuing but present practice in this zone is limited to the use of potted stock, and with broadleaf mahogany only on the more favorable sites.

Silviculture

Natural Forest

Growth measurements made during 1956 in the virgin forest of the Luquillo Mountains have produced additional basic information on tree growth under these conditions. Two extensive forest types were studied, the tabonuco type or rain forest, and the colorado type or montane thicket.

The tabonuco type is found between 600 and 2,000 feet elevation and is subject to 90 to 150 inches of precipitation annually. The forest studied had at the beginning of the period 732 trees of two or more inches d.b.b., an average basal area of 204 square feet and a volume of 4,490 cubic feet (including branchwood) per acre.

The colorado type is found between 2,000 and 3,000 feet elevation in this region, in a rainfall zone of 150 to 180 inches annually. The forest studied had an average of 713 trees, 210 square feet of basal area, and 3,503 cubic feet of volume per acre. A summary of individual tree growth of selected species in the two forests appears in Table 1.

The species included in the table produce some of the largest trees of the forest and they are of present or potential value for sawtimber. It is seen that the growth rates, even for dominant trees, are generally very slow, particularly in the colorado type. This is in part a reflection on the heavily stocked condition of these virgin forests. The more rapid growth rate of trees in cutover stands in the tabonuco type has already been reported. In the colorado type, on the other hand, partial cuttings have not materially accelerated the diameter growth of the remaining trees, so this forest is considered chiefly of protective rather than productive value.

These data are weak for some species and crown classes because all of these were not well represented in the stands sampled. However, one general relationship which is apparent is the lack of a marked increase in growth rate with the change from the suppressed to the dominant classes. Between the intermediate and dominant classes, a lesser but still very considerable difference in apparent environment, the growth rates for most species show no increase. This relationship, which is not characteristic of cutover stands, is believed to reflect a decline in vigor in the trees because of their extremely advanced age when they reach codominance or dominance in the virgin forest. An exception is *Buchenavia*, an emergent species, which apparently is capable of rapid growth to a large size.

The data for *Cecropia* and *Didymopanax* are of interest because these species, while little used here at present, have recently attracted attention as a source of light wood suitable for a variety of uses. It is also common knowledge that they are rapid growing components of secondary forests. Their intolerance is borne out by these data which show them to be of slow growth under undisturbed conditions. Regeneration of these species takes place only under openings. It is suggested further here that their rapid growth requires maintenance of low density.

A complete analysis of the 10 years of growth records in these virgin stands is being made for publication.

Plantation Management

Broadleaf mahogany (*Swietenia macrophylla* King) has produced some of the most spectacular plantations on the island in the sinkholes of the humid limestone forest area. Plantations established in the late 1930's attained by 1950 densities of 80 to 110 square feet of basal area per acre and appeared to be in need of thinnings. Some of the results of experimental thinnings made in quarter-acre plots at that time in a 13-year-old plantation, leaving stands of 70 to 80 square feet of basal area, appear in Table 2.

Table 1.—Ten-year diameter growth in the Luquillo Forest

Species	Number of trees and annual diameter growth 1946-56 by 1946 crown classes							
	Dominant		Codominant		Intermediate		Suppressed	
	No.	Growth	No.	Growth	No.	Growth	No.	Growth
		Inch		Inch		Inch		Inch
Tabonuco Type Forest								
Dacryodes excelsa Vahl	36	0.07	45	0.08	41	0.10	35	0.08
Buchenavia capitata (Vahl) Eichl.	2	0.32	2	0.29	4	0.10	2	0.01
Cecropia peltata L.	4	0.12	4	0.09	19	0.12	7	0.06
Didymopanax morototoni (Aubl.) Dec. & Planch.	2	0.18	4	0.09	19	0.12	7	0.06
Colorado Type Forest								
Micropholis chrysophylloides Pierre	11	0.09	30	0.08	44	0.09	21	0.03
Calycogonium squamulosum Cogn.	34	0.04	49	0.03	58	0.03	47	0.03
Magnolia splendens Urban	12	0.04	8	0.04	11	0.04	6	0.03
Micropholis garciniaefolia Pierre	79	0.07	74	0.05	79	0.03	39	0.04
Ocotea spathulata Mez.	17	0.02	14	0.04	17	0.01	7	0.004

Table 2.—Mahogany crop tree growth in thinning experiment

Plot	1950 Stand				Periodic annual DBH growth of crop trees	
	Crop trees		Total basal area acre			
		Av. DBH	Before thinning	After thinning	1937-1950	1950-1955
	No. Acre	Inches	Sq. Ft.	Sq. Ft	Inch	Inch
1	112	6.8	110	76	0.52	0.56
2	72	7.3	84		0.56	0.44
3	76	6.3	84	70	0.48	0.54
4	76	5.9	80		0.45	0.52

At the time the thinning was made the stands were regarded as relatively uniform in size and probably beginning to stagnate. The thinning, made largely from below, was intended to eliminate trees of poor form and to make spacing more uniform, as well as to reduce density slightly. The thinning accomplished these objectives.

It was not recognized at the time of the thinning that many of the dominant and codominant trees, subsequently designated as crop trees, were about to put forth exceptional height growth and soon dominate most of their neighbors. Unfortunately height measurements were not taken but these crop trees now stand from 10 to 20 feet above the general canopy level. They are sufficient trees of this character to constitute a full stand in the very near future, and their progress is now the best index of the productivity of the plantations.

Since individual tree growth was not measured in the period immediately preceding 1950 the only measure of prior diameter growth is the mean for the life of the plantation to that time. This mean is probably somewhat higher than the growth just before 1950 because of increasing density to that time. The tabulation shows, however, that diameter growth following 1950 is, for these crop trees, very satisfactory even where the thinning was not done. This conclusion is valid even though a decline in growth was evident in Plot 2. Furthermore, the increase in diameter growth in the thinned plots is minor.

These plots proved to lack complete comparability, so no mathematical analysis of the results has seemed warranted. However, it is apparent that a light thinning from below in such plantations neither prevents stagnation nor materially accelerates the growth of crop trees. It is chiefly of value in anticipating mortality, as is evident from the fact that 24 trees per acre died in the thinned plots subsequent to thinning (1950-55) as compared with 200 trees per acre in the unthinned plots. Thinnings from below under these conditions can be justified only where products can be disposed of at a profit. Thinnings of dominant and codominant trees of poor form, however, may still be desirable in order that future growth may be put on high quality trees.

Pilot Management

Some 8,000 acres within the Luquillo Experimental Forest were set aside during the year as a pilot demonstration management area. Within this area, which is in addition to that needed for small-scale plot tests, the best known management practices for rain forest, based upon past research, are being applied on a scale adequate to provide a source of raw materials which can be sustained at a level which will attract forest utilization industries and thus strengthen the economic basis for forestry on the island.

Two approaches toward this objective were under way during the year. One, and that of most immediate potentialities, was an attempt to develop economic outlets for trees heretofore considered of little or no value. The machining tests, now completed, have shown the basic suitability of an increased number of local woods for cabinetwork. The beginnings in wood preservation reseach, with prospect of help from the Commonwealth for equipment to test pressure treatment, may well lead to closer utilization of roundwood, most of which now has no market. Numerous promising contacts with the Puerto Rico Industrial Development Company suggest the early possibility of manufacturing new products locally from both large and small trees.

The other approach to economic forestry in the Luquillo Forest is through improvement of the timber stand itself. The forest was divided into six working circles and each of these further into compartments. These compartments are being subjected to systematic silvicultural treatment which eliminates

trees of no potential value, provides those remaining with adequate growing space, reserves large trees for which a market is likely to be found in the near future, and yet makes available the material cut for today's timber market. During 1956 some 1,076 acres were treated in this manner. At the outset, since the forest has been excessively cut in the past, most of the trees cut are not merchantable, but with the elimination of the worst trees and with the anticipated improvement of industrial utilization of local wood it is believed that in the second cycle a substantial timber sale business will develop.

FOREST UTILIZATION RESEARCH

Research in forest utilization was limited primarily to the determination of wood properties and to wood preservation. In addition efforts were made to apply the results of research to improve local utilization of forest products.

Wood Properties

Tests of machining properties, air seasoning characteristics, and certain related physical properties of 62 local timbers were completed. All material tested locally was graded, and additional material was shipped to the Forest Products Laboratory for tests of turning. The analysis of these tests is now completed and the report is in manuscript form.

The preliminary conclusions from this work, described in last year's report still hold. Many of the woods tested compare favorably with hardwoods which are widely used elsewhere. A preliminary listing of the species into five utility classes was made for immediate use in revising the instructions for pilot-demonstration stand improvement work in the Luquillo Experimental Forest. Those instructions now reflect both the silvicultural and utilization characteristics of the tree species of the forest.

Compilation of the known information concerning the properties and uses of 75 timbers of the Caribbean region has also continued and the manuscript is now ready for review. This project is in response to a request from the Timber Trade Conference of the Caribbean Commission.

Wood Preservation

With almost no use of wood preservatives in Puerto Rico at present and with wood products locally in disrepute because of susceptibility to insect attack and decay one of the most promising lines of forest utilization research is the development of practical methods for local wood preservation. Wood preservation should materially improve the market for the less used timbers and at the same time reduce the demand for fence posts, most of which come from promising young trees in forests already overcut. Furniture must be protected against dry-wood termites and power-post beetles, and posts and construction timbers must be protected against a host of boring insects, including wet-wood termites and also against decay where exposed to the soil or the weather.

The some 50,000 farms of Puerto Rico use an unknown but tremendous number of fence posts each year. With the average service life of untreated posts not more than 24 months, the replacement of fence posts constitutes not only a continuous heavy drain on scattered privately-owned forests but a growing cost to landowners in terms of the labor required.

The Center has made a few preliminary tests to determine the order of magnitude of treatability of local woods and their service life after treatment. Methods used have been crude but the results have been followed for indications of what might be expected. Examinations of three of these tests were made during the year.

The earliest local tests of post preservation, made in 1944 ,concerns *Casuarina equisetifolia* Forst posts treated with creosote by

the hot-and-cold bath method. The hot bath, at 90°C or higher, was maintained for 7 to 9 hours. Penetration ranged from 2.0 to 2.7 gallons per cubic foot. The treated posts were set in a humid shady area within the rain forest at an elevation of 1,200 feet. The untreated controls all decayed within 4 years, whereas the treated posts are still sound, after 12 years, and with no sign of appreciable deterioration. Posts only butt-treated became unserviceable as rapidly as the untreated posts.

A second test included 33 post species and used the cold- soaking method with a 5 percent pentachlorophenol solution in diesel oil. The length of treatment was 5 days and absorption ranged from 2 to 19 pounds of solution per cubic foot, varying with the species. After 4 years the posts are still sound, although there is some signs of leaching of the preservative on the outer surface of the posts.

A work plan is in preparation for testing hot-and-cold bath treatment using creosote and pentachlorophenol and for the double diffusion method. A pilot plant is being procured for these tests. In addition the Commonwealth government is procuring a pressure treatment pilot plant for the use of the Center in testing this process. The construction of the first commercial pressure treating plant in Puerto Rico during the year, a $100,000 facility with a cylinder length of 42 feet and a daily capacity of 16,000 board feet of lumber, promises to provide another opportunity for research in this field. The plant is now using Wolman salts exclusively, and the owner has offered his cooperation in setting up local tests.

Technical Assistance

The forest utilization research staff, because Puerto Rico has heretofore had little technical assistance in this field, is subject to a large number of requests for advice from importers of wood, sawmillers, retailers, manufacturers of millwork and furniture, industrialists interested in setting up wood using plants in Puerto Rico, and public agencies such as the Puerto Rico Industrial Development Company. Attention to these requests, while not project work in research, is a healthy counterpart of our program. Efforts along these lines are what may be termed as putting research into practice as well as keeping abreast of the local situation. As a result of these contacts we obtain first-hand information on needed research and on new opportunities for complete utilization of our forest products.

At the request of the Development Company the Center arranged for Dr. James Bethel of the University of North Carolina to make a study of the feasibility of a Federal-Commonwealth cooperative proposal to set up a utilization plant based upon the resources of the Luquillo Experimental Forest. Dr. Bethel's report recommended an experimental plant to include sawmill, dry kiln, post treating facilities, and a charcoal briquetting plant. The Development Company has since been trying to interest outside industrialists to undertake at least part of the proposal for immediate profit rather than for research purposes, using the entire island as a source of raw materials, rather than just the Experimental Forest. Under either approach the research program, as well as forest utilization on the island, is certain to gain materially.

A large importer of tropical woods requested advice from the Center on techniques for seasoning. Methods of piling were suggested, a moisture meter was procured and calibrated, and a brief study was made of the drying of cedro macho, *Carapa procera* DC. Use of proper piling made possible reduction of moisture content from 45 to 20 percent in 56 days and without drying defects except limited end checking of wide boards.

A number of requests for information concerning the prospects for local charcoal and briquet manufacture have reached the

Center through the Development Company. Information has been provided as to the general location and volume of raw materials and samples have been provided for testing. The prospects for a local charcoal industry seem bright because of low labor costs and accessibility to the market of the eastern United States. Charcoal manufacture could also go far to improve the utilization of local forests.

Special interest on developing new uses for local forest products has recently centered around yagrumo hembra, *Cecropia peltata* L., one of the most common trees of mountain forests, which grow rapidly and yet is almost unused at present. The wood of this species is too weak for the conventional uses of forest products such as construction and furniture and possibly too light for good charcoal. However, for specialty uses such as airplane models, excelsior, chipboard, and pulp products it appears to have considerable promise. Freshly cut wood is not as susceptible to staining or insect attack as most other woods. It seasons relatively rapidly with few defects. A reanalysis of past forest inventories has begun to isolate better information as to the location and volume of this timber available in Puerto Rico. Several industrialists have shown great interest in its possibilities. Furthermore, its adaptability to adverse sites and rapid growth suggest that if a market is developed it may become a popular farm crop for the reforestation of steep lands in private ownership. Reforestation tests will be undertaken next year.

A variety of inquiries have been received concerning other wood products which might be produced locally, such as arrows, particle board, prefabricated houses, boats, pallets, boxes, handles, brushes, and kites. The Development Company has come to use the Center as an important source of basic information for all wood industry inquires. In most cases Center personnel have an opportunity to talk directly to the industrialists concerned.

A beginning has been made in bringing together a collection of the important wood-destroying fungi of Puerto Rico. Specimens collected are being sent to the appropriate authorities for identification. This information is basic to future attempts to inhibit decay with preservative treatment.

Informe Sobre un Levantamiento Ecológico de la República de Panamá [1/]

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INTRODUCCION

Accediendo a una solicitud que el gobierno de la República de Panamá dirigiera al Programa de Cooperación Técnica de la Organización de los Estados Americanos, se efectuó un reconocimiento ecológico de Panamá durante parte de los meses de abril y mayo de 1955. Al considerar el tamaño de Panamá y el hecho de que los dos técnicos solamente disponían de un mes para este trabajo, la parte cartográfica se limitó a las delineaciones de las zonas de vida o formaciones forestales del país. Sin embargo, éste era el objetivo del proyecto y el informe adjunto describe estas áreas y su relación para usos agrícolas y forestales.

Un estudio ecológico de esta naturaleza se considera como uno de los pasos básicos para planificar el uso racional de los recursos de una nación. Al mismo tiempo se hizo un intento para delinear aproximadamente las áreas más prometedoras para concentrar las labores de extensión agrícola, los levantamientos futuros y el desarrollo forestal. Las experiencias, tanto ventajosas como desfavorables de los otros países de la región en cuanto a la utilización de los recursos renovables dentro de las diferentes zonas de vida, se han tomado muy en cuenta como una guía para Panamá, donde la población todavía alcanza poca densidad.

A fin de desarrollar y mantener un nivel satisfactorio de vida, el hombre debe mantener un equilibrio ecológico en relación con su medio ambiente. Si trabaja en armonía con las condiciones naturales, puede desarrollar un uso eficiente y permanente de los recursos renovables, los que le proveerán con todos los beneficios necesarios de una vida holgada. Si trabaja contra la naturaleza, los resultados redundarán en el despilfarro de los recursos, originando la pobreza y numerosos problemas económicos y sociales. Afortunadamente, Panamá todavía se encuentra en una posición favorable para poder guiar su propio desarrollo y, si tal es su deseo, puede desarrollar una economía fuerte y sana y una nación vigorosa.

Antes de entrar en la discusión, queremos dejar constancia de nuestra sincera gratitud a las muchas organizaciones y personas que cooperaron en distinta forma y con tanta buena voluntad a fin de facilitar nuestras labores. La organización del SICAP, bajo la dirección del Sr. Benjamín Birdsall, hizo los arreglos para todos los viajes dentro del país y facilitó transporte y otros gastos en relación con el levantamiento ecológico. El Dr. Menalco Solís y el Sr. Laurence Cummings, del SICAP, se encargaron de organizar los viajes específicos y el último nos acompañó en la mayoría de los recorridos. El Sr. Louis Guzmán y otros de la oficina central cooperaron en la recolección de datos y los agentes del SICAP resultaron ser de mucha ayuda en el campo, especialmente para los arreglos locales.

La Chiriquí Land Co. facilitó amablemente el transporte motorizado dentro de la provincia de Chiriquí. También el Sr. Mac Arosemena y su organización, el Instituto de Fomento Económico, fueron muy útiles al arreglar algunos viajes cercanos de la ciudad de Panamá, hacia el este. El Honorable Diputado M. Otón, de la provincia del Darién, nos ayudó considerablemente en la región de

1/ Traducción del artículo "Report of an Ecological Survey of Panama" que aparece en el C. F. Vol. 17 (3 &4) págs. 92-110. Julio - Dec., 1956.

El Real. A todos ellos y muchos otros, demasiado numerosos para mencionarlos aquí, queremos expresar nuestro agradecimiento por su valiosa asistencia que hizo dicho levantamiento más eficiente y más agradable.

Algunos Datos Geográficos de Panamá

La República de Panamá comprende el sureste de lo que se considera generalmente la América Central, colindando con Colombia hacia el este, Costa Rica al oeste y con los océanos Atlántico y Pácifico, respectivamente, en sus costas del norte y del sur. El área del territorio es de 75.422 kilómetros cuadrados o 29.128 millas cuadradas incluyendo los 1.432 kilómetros cuadrados o 553 millas cuadradas de la Zona del Canal. La población del país se calculó en 851.900 en el año 1952, lo que representa una densidad de solamente 11,3 habitantes por kilómetro cuadrado o 29 habitantes por milla cuadrada. En tamaño Panamá esencialmente se parece a un arco estrecho o irregular con una dirección general de este a oeste y variando en ancho aproximadamente unos 50 hasta 200 kilómetros, o sea de unas 30 a unas 120 millas. La misma orientación es la que presentan las cordilleras montañosas principales que forman la espina dorsal del país con solamente una interrupción apreciable en el centro alrededor del Canal de Panamá. Dicha cordillera alcanza una altura de algo más de 3.300 metros u 11.000 pies en el Volcán Chiriquí o Barú en el extremo oeste pero las elevaciones son mucho menores hacia el este del Canal. Otras cordilleras montañosas de menor elevación se encuentran en la península de Azuero hacia el sur, otra a lo largo de la frontera colombiana y otra bordeando la costa del Pacífico al este de la provincia del Darién.

En vista de las numerosas estribaciones sobre una faja tan estrecha del territorio, queda poco espacio para las llanuras. Las mayores de éstas se encuentran en el lado del Pacífico tanto en la provincia del Darién, donde se encuentran los ríos más grandes, como en las provincias de Chiriquí, Veraguas, Coclé y Los Santos, hacia el lado oeste del país.

Factores Climatológicos

Temperatura

La República de Panamá se encuentra enteramente dentro de la zona tropical por lo que todas sus partes bajas tienen temperaturas medias anuales de más de 24°C. Las temperaturas más altas se registran en las áreas más secas de la vertiente del Pacífico del país.

Al aumentar la elevación, se producen temperaturas más bajas que dan lugar a cuatro fajas altitudinales de vegetación entre ellas bien definidas. La más baja de éstas es la faja basal tropical que va desde el nivel del mar hasta unos 600 metros en las vertientes del Caribe y sube aproximadamente a 700 metros en las vertientes del Pacífico.

La faja subtropical se extiende desde estas últimas elevaciones hasta una altura de aproximadamente 1.500 metros sobre el nivel del mar. La faja montano-bajo se eleva desde el límite superior de la faja subtropical hasta aproximadamente 2.600 metros sobre el nivel del mar. La mayor parte de esta faja se encuentra restringida a una porción al oeste de Panamá, en la cordillera de Talamanca y en la Serranía de Tabasara, pero algunas áreas más reducidas se encuentran en el este de Panamá, a lo largo de la frontera con Colombia. La faja montano está restringida a unas áreas aisladas en los picos más altos de la cordillera de Talamanca. Aunque pueden encontrarse unas pocas plantas subalpinas sobre el pico del Volcán Chiriquí, no se alcanza la faja subalpina en Panamá.

Las superficies totales y aproximadas de las diferentes fajas altitudinales y sus respectivos porcentajes del área total del país, se dan en la siguiente tabla:

	Total Area en Km2	Porciento Total del área
Faja Basal tropical	56.430	76,3
Faja Subtropical	13.800	18,6
Faja Montano-bajo	3.530	4,8
Faja Montano	250	0,3
Total	74.010	100,0

Precipitación Pluvial

Dentro de las fajas altitudinales, las diferencias en las precipitaciones anuales de lluvia dan lugar a cambios significativos en la vegetación natural y en forma correspondiente en la agricultura. Estas divisiones naturales que se denominan zonas de vida o formaciones vegetales, están delimitadas en el Mapa de Panamá que se adjunta.

Usualmente, las zonas de transición donde dos formaciones se encuentran no son muy extensas y una sola línea delimita el cambio desde una zona de vida a la otra. Sin embargo, en la zona del Darién encontramos que sobre una extensión considerable, la precipitación total anual era muy cercana de los 2.000 milímetros u 80 pulgadas y el cambio en precipitación es tan gradual, que las zonas de transición son lo suficientemente extendidas como para merecer una delimitación separada.

La precipitación pluvial en la costa y las vertientes del Caribe concuerdan con las normas generales que rigen para el área del Caribe. Los vientos alisios del noreste y del este traen aire fuertemente cargado de humedad hacia la tierra y la precipitación resulta esencialmente orográfica. La mayor precipitación anual ocurre probablemente en la parte inferior de la faja montano-bajo o en la parte superior de la faja subtropical, cerca de los 1.500 metros de elevación. Sin embargo, no existen en la actualidad las estaciones meteorológicas que permitirían comprobar tales precipitaciones en estos puntos de la vertiente del Caribe.

Durante la estación de lluvias, el movimiento de aire atraviesa la división continental hasta cierta distancia en tal forma que las partes superiores de los declives al sur y al suroeste están definitivamente influenciadas por el régimen climatológico del Caribe. Solamente en la vecindad de la Zona del Canal, donde la región es generalmente baja, se extiende esta influencia del Caribe durante la estación lluviosa, a través de todo el Istmo llegando hasta el Pacífico. Esto se nota exactamente al oeste del Canal y puede observarse en la vegetación a lo largo de la carretera desde un poco antes de La Chorrera hasta después de Capira.

En el lado del Pacífico, la precipitación es en su mayor parte, conveccional y ocurre durante la estación lluviosa cuando la zona de calmas ecuatoriales (doldrum belt), se ha desplazado hacia el norte desde la América del Sur, hasta cubrir Panamá. Sin embargo, parece que aquí se produce una fuerte influencia de los vientos del sureste en aquellas partes del Istmo que están expuestas al suroeste, lo que se aprecia en una indicación de mayor precipitación y una vegetación similar a la del lado del Caribe.

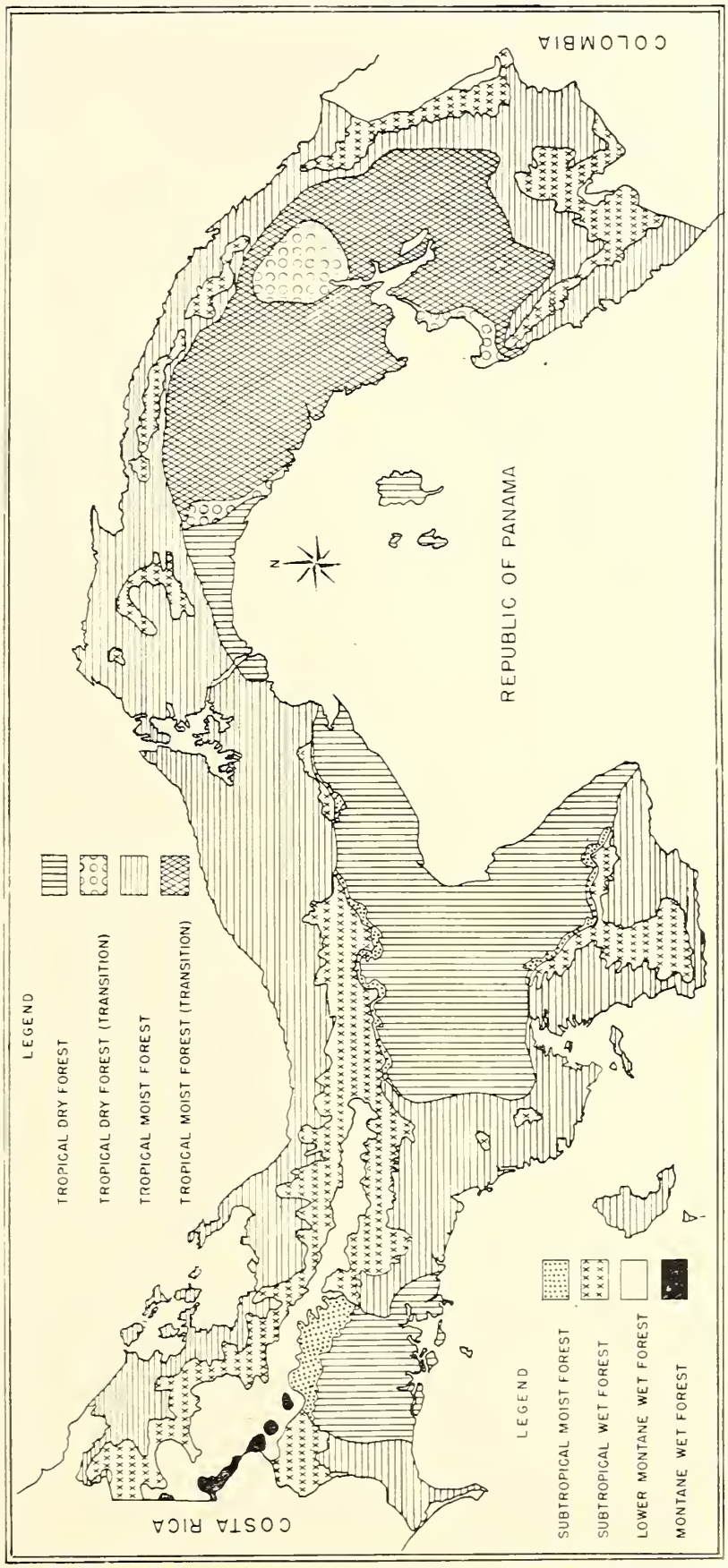
En general pues, todo el lado del Caribe varía de húmedo a muy húmedo mientras que el lado del Pacífico está dividido en subregiones húmedas o secas. La estación seca es larga y fuerte en las formaciones secas del Pacífico. También en la formación "bosque húmedo" de este lado la estación seca es más marcada que en la misma zona de vida al lado del Caribe.

El área más seca de Panamá se observó hacia el este de la Península de Azuero.

Cerca de la frontera colombiana, hay indicaciones de que se entra en una región climatológicamente diferente que es generalmente más lluviosa, de tal manera que, las direcciones de los vientos y las barreras montañosas no aparecen aquí tan importantes como al oeste del país, para influenciar la precipitación.

Vientos

Los vientos son significativos en el clima panameño, mayormente por producir lluvias orográficas y acentuar la sequía sobre la vertiente del Pacífico cuando los fuertes vientos alisios cruzan el Istmo durante la estación seca. Afortunadamente, Panamá está fuera de los itinerarios de los huracanes que cruzan el área del Caribe hacia el norte. Sin embargo, en relación con los vendavales, las corrientes locales pueden alcanzar tal intensidad que llegan a causar derribos y afectar ciertos cultivos como el banano.



Zonas de las Formaciones Vegetales de la República de Panamá

Factores Edáficos

Mientras los factores climatológicos de temperatura y precipitación determinan las diferentes zonas de vida o formaciones, dentro de cada formación, las asociaciones vegetales, la fisonomía o apariencia de la vegetación y el mejor uso que el hombre puede hacer de estas áreas, dependen de los factores edáficos, o sea, del suelo. Estos factores incluyen la topografía, los niveles freáticos y las condiciones físicas y la composición química del suelo.

Topografía

Panamá es un país de elevaciones mayormente bajas o medianas. Solamente al oeste del país pueden encontrarse extensiones apreciables dentro de las fajas montano bajo y montano. Como una continuación de la elevada serranía montañosa de Costa Rica, la cordillera de Talamanca y la serranía de Tabasara se presentan en forma de una cordillera alta pero con interrupciones, que alcanzan su mayor elevación a 3.478 metros en el Volcán Chiriquí.

La mayor parte de la faja subtropical comprende una topografía accidentada con solamente muy pocas extensiones de terrenos llanos o ligeramente inclinados, localizados en los valles o en las cumbres de las lomas más anchas. También la faja tropical que está más baja y que cubre la mayor parte de Panamá, es predominantemente ondulada y quebrada. Dentro de la formación bosque húmedo sobre la vertiente del Caribe, hay numerosas fajas aluviales a lo largo de los ríos pero solamente en la provincia de Bocas del Toro y, al oeste cerca del Canal, tal como entre la Chorrera y el Lago Gatún, se encuentran algunas áreas extensas de terrenos llanos o ligeramente inclinados.

Del lado del Pacífico, se encuentran cuatro zonas de terrenos llanos y ligeramente inclinados que tienen importancia significativa: la sección David-Armuelles, el área de la formación bosque seco de Coclé-Veraguas-Herrera, una franja que se extiende al este de la ciudad de Panamá y que remonta, estrechándose, el valle del río Bayano y finalmente, el conjunto de los valles formados por los ríos de la provincia del Darién.

Altos Niveles Freáticos y Drenaje Excesivo

Dondequiera que el nivel de las capas freáticas es alto durante parte o durante todo el año, la vegetación de estas áreas es bien distinta de los terrenos boscosos adyacentes con drenaje normal. Las más extensas de tales áreas se encuentran en los valles inferiores en la provincia del Darién y adjunto a las lagunas en la provincia de Bocas del Toro. Asociaciones similares pero de extensión reducida se encuentran también a lo largo de los ríos de la costa en muchas partes del país.

Con una extensión mucho menor, están las áreas de suelos arenosos o colinas calcáreas donde el drenaje es excesivo, como se refleja en una vegetación menos exuberante y más xerofítica. Algunos ejemplos de tales áreas pueden observarse alrededor de Patiño en el Darién, en las colinas al sur de Conchita sobre el río Bayano y en algunas áreas de sedimentos gruesos volcánicos de la provincia de Chiriquí.

Existe todavía otra combinación donde una capa dura impermeable (hard pan) produce el estancamiento de agua durante la estación de lluvias y un desecamiento excesivo durante la estación seca y puede apreciarse en las llanuras sabanosas de la región de Coclé. Sin embargo, los suelos de estas zonas de sabanas también adolecen de pobreza química lo que podría atribuirse por una parte a su composición original y por otra a los repetidos y extensos incendios anuales.

Condiciones Químicas y Físicas

Aun cuando es generalmente reconocido que las condiciones físicas y químicas de un suelo debajo de la selva virgen, puedan ser satisfactorias o excelentes, lo que realmente reviste importancia especial para el hombre en relación con su agricultura, son aquellas

tierras capaces de mantener tales condiciones durante largo tiempo después de cortarse el bosque. Las áreas que más se aproximan para llenar dichos requisitos en Panamá, son los terrenos llanos aluviales y las áreas de suelos volcánicos geológicamente recientes. Tales suelos volcánicos recientes solamente pueden encontrarse al extremo oeste de Panamá.. Allí, donde los terrenos llanos aluviales han sido enriquecidos con suelo volcánico reciente, se encuentran localizados los mejores suelos agrícolas del país. Sin embargo, existen ciertas zonas extensas de suelos aluviales en otras secciones de Panamá, las que pueden abastecer en forma satisfactoria las necesidades agrícolas del país durante cierto tiempo en el futuro.

Los suelos pedregosos son comunes en el área seca de la provincia de Chiriquí y dentro de la formación bosque seco, hay extensas zonas de baja fertilidad que pueden encontrarse en la vecindad de David, en Coclé, Veraguas y al este del Canal. En la formación bosque húmedo, entre la Chorrera y la costa puede observarse una zona más reducida de suelos muy pobres que da lugar a una vegetación de sabana.

Factores Bióticos

Aun cuando bajo este título, los ecólogos consideran el afecto de todas las formas de vida sobre la vegetación, consideraremos solamente las principales influencias provocadas por el hombre con sus animales domésticos y el fuego, causado casi exclusivamente por el hombre.

La aparente concentración de nombres de lugares en la zona de vida tropical seca, puede apreciarse con una rápida ojeada al mapa. Estos fueron los principales centros de población durante los siglos que siguieron a la primera colonización europea de Panamá y muy probablemente constituyeron anteriormente los principales centros de población indígena basados en el cultivo del maíz. Esto se debe primordialmente al esfuerzo menor que se requería para controlar la vegetación leñosa que competía con los cultivos o, después de la colonización de los españoles, con los pastos para su ganado. Las prolongadas quemas periódicas en estas regiones secas han alterado enormemente la vegetación forestal original y han conducido al empobrecimiento de los suelos, especialmente en las laderas.

En el siglo pasado, se han desarrollado tres concentraciones de poblaciones, una dentro y cerca de la zona del Canal atravesando el Istmo y las otras dos en conexión con el cultivo del banano en la provincia de Bocas del Toro y la comarca del Barú.

Desde los varios centros de concentración humana de ambas zonas de vida, la población creciente está actualmente desplazándose en las áreas adyacentes. La influencia del hombre en el resto de la República es mucho menos intensa y tiende hasta la fecha a confinarse a unas franjas angostas a lo largo de la costa, de los ríos y de las carreteras que han sido abiertas en recientes años.

En general, la influencia total del hombre sobre la vegetación de Panamá, todavía es bastante reducida y se restringe a ciertas zonas de concentración. Dentro de estas últimas, las áreas afectadas por el cultivo agrícola son mucho menores que aquéllas donde la vegetación ha sido removida por el hombre o el fuego para fines de pastoreo.

Sin embargo, la población ha alcanzado actualmente una cifra tal que los aumentos geométricos subsiguientes están destinados a producir cambios profundos en la vegetación y paisajes naturales de Panamá con solo unas cuantas generaciones venideras. En este informe se discutirán subsecuentemente la necesidad de planificar y los posibles resultados del impacto futuro del hombre sobre los recursos naturales de Panamá.

La Vegetación Natural de Panamá

La vegetación natural de cualquier área depende de los factores climatológicos y edáficos que prevalecen en este sitio. Dentro de una provincia biogeográfica, muchas

especies de plantas pueden ser usadas como indicadoras de variaciones en el clima o los suelos. Esto resulta especialmente importante en Panamá donde los datos meteorológicos son escasos y los suelos han sido poco estudiados. En el presente estudio, las observaciones se han limitado mayormente a las especies arboreas, las que debido a su tamaño y su mayor exposición a los elementos climatológicos, se han considerado como los mejores indicadores. Sin embargo, en aquellos sitios donde el hombre había realizado grandes desmontes, se encontró que era necesario utilizar igualmente algunos elementos menores de la vegetación, además de los árboles aislados remanentes.

Puesto que este levantamiento era un reconocimiento ecológico y el tiempo fué sumamente limitado, se hicieron pocas recolecciones y no se intentó identificar a todos los elementos arbóreos de determinadas asociaciones. En muchas áreas se compilaron listas de árboles con el propósito primordial de localizar los árboles indicadores que resultasen ser de importancia especial para clasificar el área. De esta manera se pueden interpretar no solamente los factores climatológicos y edáficos, sino también el uso agrícola presente y potencial.

El Bosque Tropical Seco

En Panamá se caracteriza por los siguientes árboles:

Acrocomia sclerocarpa Mart. Palma pacora o Corozo.
Albizzia caribaea
Apeiba tibourbou Aubl Cortezo
Bombacopsis quinatum (Jacq.) Dugand Cedro espino
Bumelia sp. Pino alegre (?)
Calycophyllum candidissimum (Vahl.) D.C. Madroño
Chlorophora tinctoria (L.) Gaud. Mora
Cochlospermum vitifolium (Willd.) Spreng Poroporo
Diphysa robinioides Benth Macano
Enterolobium cyclocarpum (Jacq.) Gris. Corotú
Luehea candida (?) (DC.) Mart.
Pithecolobium saman Benth.
Platymiscium pinnatum (Jacq.) Dugand Quirá
Prosopis juliflora (Sw.) DC.
Pseudosamanea guachapele (H. B K.) Harms
Sciadodendron excelsum Gris. Lagarto
Simarouba glauca DC.
Sterculia apetala (Jacq.) Karst. Panamá
Sweetia panamensis Benth.
Tabebuia chrysantha Guayacán
Xylopia frutescens Aubl. Malagueto macho.

Hay aproximadamente unas 100 especies de árboles de todos los tamaños en esta asociación, sobre buenos suelos. Tampoco enumeramos aquí algunos árboles espectaculares tales como *Ceiba pentandra* Gaertn. - ceiba; *Bursera simarouba* (L.) Sarg. - carate; y *Didymopanax morototoni* (Aubl.) D. & P. porque tales especies se encuentran también en el bosque tropical húmedo. Sobre suelos más pobres, tales como los terrenos de sabana de la vertiente del Pacífico, el número de especies es más reducido, el bosque original estaba compuesto de árboles de menor estatura, hay más leguminosos espinosos tales como *Prosopis juliflora* (Sw.) DC y *Acacia farnesiana* Willd. y encontramos en algunos sitios altos porcentajes de especies resistentes al fuego y que toleran los suelos pobres, tales como *Curatella americana* L. y *Xylopia frutescens* Aubl.

Las dos asociaciones de suelos pobres ocupan extensas áreas dentro de esta zona de vida, como por ejemplo en las sabanas y al pie de las colinas de la provincia de Coclé y alrededor de David, en la provincia de Chiriquí.

A lo largo de las corrientes de agua o sobre las llanuras aluviales cercanas a los ríos, donde el nivel freático es alto, pueden encontrarse árboles de la formación tropical húmeda tales como *Anacardium excelsum* (Bert. & Balb.) Skeels - espavé, pero éstas no son aptas para resistir las sequías largas sobre las vertientes.

Las cuatro asociaciones de zonas secas mencionadas, constituyen los pricipales grupos de plantas que abarcan áreas apreciables. Hay otras asociaciones vegetales más reducidas y de interés científico pero no se consideraron importantes para este estudio. En cuanto a los bosques de pantano, se tratarán en una parte posterior de este informe.

El Bosque Tropical Húmedo

Incluyendo la zona de transición hacia el bosque seco, cubre aproximadamente la mitad de la superficie de Panamá. No pudimos separar la formación "bosque muy húmedo" aunque hay indicaciones a lo largo de la costa de San Blas y más hacia el oeste, de que posiblemente haya extensiones considerables que pudieran tener una precipitación de más de 2.000 milímetros (160 pulgadas), perteneciendo por lo tanto a otra formación. Sin embargo, el recorrido dentro de la faja forestada de la costa del Caribe es penoso y el tiempo no nos permitió efectuar extensos viajes al pie de estas colinas. Las especies arbóreas características del bosque tropical húmedo se enumeran a continuación:

Anacardium excelsum (Bert. & Balb). Skeels Espavé.
Brosimum spp.
Carapa guianensis Aubl.
Cecropia obtusifolia
Centrolobium patinense Pittier
Coccoloba tuerckheimii D. Sm.
Couroupita panamensis
Dipteryx panamensis
Gustavia Sp. Membrillo
Iriartea exorrhiza Mart.
Jacaranda copaia (Aubl.) D. Don
Lecythis sp. Coco
Luehea seemannii Tr. & Pl. Guácima
Pentaclethra macroloba (Willd.) Kuntze.
Theobroma purpureum Pittier Cacao Cimarrón.
Virola spp.
Warcewieczia coccinea

Bosques de Transición

Generalmente las áreas de transición entre dos zonas de vida son estrechas y no se clasifican aparte, pero en la provincia del Darién encontramos que estas zonas de transición resultaron ser tan extensas que las delimitamos separadamente. En tales áreas de transición, ocurre una mezcla de especies arbóreas de cada una de las formaciones, más ciertas especies que son típicamente especies de transición.

El cuipo, *Cavanillesia platanifolia* H.B.K., árbol muy interesante, es uno de éstos. Cuando se atraviesa el istmo de Panamá cerca de la zona, este árbol enorme se encuentra bastante bien restringido a las orillas de los bosques húmedos y secos, formando fajas angostas. Sin embargo, en el Darién, esta especie se encuentra distribuída sobre una amplia sección indicando claramente que todo el área es de transición.

Aquella porción del bosque húmedo que se describe como bosque de transición, contiene un porcentaje mucho más alto de especies maderables valiosas que el que corrientemente se encuentra en el bosque húmedo; las condiciones climatológicas también son excelentes para el uso agrícola.

Bosques de Pantano

Los bosques de pantano de Panamá son extensos y especialmente interesantes para las industrias forestales potenciales debido a su composición de solamente una o muy pocas especies. Tales rodales puros son raros en los trópicos excepto cuando se encuentran ciertas condiciones edáficas especiales. Entre las diversas asociaciones, las cuatro más extensas son respectivamente los manglares, los bosques de alcornoque, los bosques de cativo y los bosques de orey.

Aun cuando existan bosques de pantano de diferentes tamaños, esparcidos a lo largo de las costas de la República, nuestras observaciones más detenidas se realizaron en las provincias de Bocas de Toro y el Darién, donde

dichas asociaciones se presentan sobre miles de hectáreas. Aunque la precipitación es considerablemente mayor en Bocas del Toro, la mayor diferencia entre ambas zonas se verifica en la fluctuación de los niveles de las mareas. En el lado del Caribe, solamente hay una diferencia de algo más de 50 centímetros o 20 pulgadas entre los niveles promedios de marea alta y marea baja, mientras que en el Darién esta diferencia alcanza cerca de 6 metros o 20 pies.

Con una diferencia tan grande entre las mareas altas y bajas, en el Darién, los efectos de las mareas se hacen sentir río arriba hasta considerable distancia, aun cuando la elevación del agua se deba al efecto de represa producida por la entrada de la marea. El punto aproximado hasta donde alcanza el agua salobre al subir un río, parece que está marcado por la desaparición del mangle rojo, *Rhizophora mangle* L. y la aparición de *Montrichardia arborescens*, (L.) Scholt. un elevado aroide que crece sobre el pantano blando de los bancos ribereños. Las inundaciones más fuertes se presentan cuando las mareas más altas coinciden con períodos de fuerte precipitación pluvial y con los ríos con mucho caudal.

Fig. 1.—*En Panamá los rodales densos de mangle rojo* (Rhizophora mangle) *alcanzan tamaños de 24-27 metros de promedio y diámetros a menudo superiores a 40 centímetros.*

Fig. 2.—*Los bosques de cativo* (Prioria copaifera) *forman densos y valiosos rodales a lo largo de los ríos del Darién.*

Manglares

En la provincia del Darién, hay miles de hectáreas de pantanos ocupados por formaciones puras de mangle rojo que se aniegan periódicamente con las mareas. Con las mareas altas, el agua salada atraviesa fácilmente el bosque de mangle rojo, lo que posiblemente explica la gran extensión de éstos. En Bocas del Toro, el mangle rojo solamente se encuentra en la orilla del pantano con el mangle negro, *Avicennia marina* (Forsk.) Vierhapper y el mangle blanco, *Laguncularia racemosa* Gaertn. ocupando el área contigua hacia la tierra firme. En el Darién, estas últimas especies aparecen primero sobre los bancos ribereños donde el agua "dulce" de los ríos reduce la salinidad.

Los rodales del mangle rojo alcanzan un promedio de aproximadamente 24 a 27 metros de altura, o sea, cerca de 80 a 90 pies, con buenos fustes rectos y altos volúmenes por unidad de superficie. Actualmente se explotan pero solamente utilizan la corteza del árbol y aún dichos cortes no han sido muy extensos.

Bosques Pantanosos de Alcornoque (aparentemente *Mora excelsa* Benth).

También en la provincia del Darién dicha asociación cubre extensas zonas, ocupando aparentemente el área de los manglares cuando el nivel de la tierra es más alto. Aquí hay más tierra firme que parece encontrarse encima del nivel normal de las mareas pero la que al ser inundada es cubierta por el agua salobre.

Los árboles alcanzan diámetros mayores que el mangle rojo y no son tan altos o tan rectos. Sin embargo, la cantidad total de madera de este rodal de una sola especie, es muy alta.

Bosques Pantanosos de *Pterocarpus officinalis* Jacq.

Este árbol leguminoso con delgadas raíces tablares, forma ocasionalmente rodales puros al lado de los manglares, pero sobre terrenos posiblemente más blandos y más afectados por la presencia de agua salobre que en los bosques de alcornoque. De todas maneras, no son extensos en ninguna parte de Panamá y no son importantes como bosques comerciales.

Bosques Pantanosos de Orey

En la provincia de Bocas del Toro se encuentran extensos rodales casi puros de orey, *Campnosperma panamensis* Standl. sobre las tierras bajas, casi al nivel del mar de las islas, penínsulas y playas de tierra firme. Al parecer, estas regiones no están realmente inundadas por las mareas pero existe un alto nivel freático de aguas salobres.

La asociación contiene algunos árboles pequeños de otras especies en el soto bajo y de vez en cuando un árbol grande de *Symphonia globulifera* L. dentro o encima del dosel general. El rodal no contiene un volumen muy alto, puesto que los árboles varían mayormente de 25 a 45 centímetros de diámetro, o sea, de 10 a 18 pulgadas y su altura no parece excederse mucho de los 18 metros o 60 pies.

Bosques de Cativo

Sobre las llanuras bajas del Darién se encuentran extensos terrenos cubiertos por rodales prácticamente puros de cativo, *Prioria copaifera* Gris. Este árbol parece crecer en las llanuras, sobre el nivel corriente de las mareas semejantes a los bosques de alcornoque, pero los que al anegarse, solamente se cubren de agua "dulce". Algunas otras especies, tales como el tangaré, *Carapa guianensis* Aubl. y *Quararibaea* están mezcladas con el cativo aun en aquellos sitios donde las inundaciones son más altas, pero cuando el terreno se va elevando gradualmente, sigue aumentando la proporción de las especies pertenecientes al bosque tropical húmedo.

Tales rodales, según fueron descritos por Lamb, contienen altos volúmenes por unidad

de superficie, ya que el cativo es un árbol alto de fuste recto, de gran diámetro y se encuentra en rodales densos.

Bosques Pantanosos de

Pachira aquatica Aubl.

Más arriba de los bosques de alcornoque del río Sambú, observamos pequeñas áreas de rodales puros de este árbol. La asociación parece que se restringe a los suelos blandos, inestables que son anegados por agua dulce solamente. Esta asociación probablemente, llena el papel de estabilizador de tales suelos para luego ser reemplazada por el catival. En este rodal los árboles alcanzan menos de 30 pies de alto con diámetros menores de 20 centímetros u 8 pulgadas. La asociación no tiene importancia para la producción de madera.

Fig. 3.—Interior de un bosque de alcornoque (probablemente Mora excelsa) *en las orillas inferiores de los ríos del Darién. Aunque de alto volumen por unidad de superficie, los árboles pocas veces tienen buena forma.*

Fig. 4.—Vista dentro de un rodal de Pterocarpus officinalis, *a menudo anegado. Los árboles son más bien delgados pero tienen grandes y delgadas raíces tablares.*

Pantanos de *Manicaria*

En la provincia de Bocas del Toro, observamos pantanos de palmas de agua dulce que también se encuentran más hacia el oeste de de la costa del Caribe. La *Manicaria* es una palma de hojas grandes y de tronco corto. No se hicieron observaciones dentro de estos pantanos, pero se notó que en algunos sitios la reproducción de tangaré o cedro macho, *Carapa guianensis* Aubl. estaba empezando a desarrollarse, sobrepasando a las palmas.

Bosques Subtropicales

Se dedicó poco tiempo a las observaciones de la vegetación de esta faja localizada a mayor elevación que la de los trópicos bajos mayormente porque tienen mucho menos importancia económica que los bosques de las bajuras. Cuando la precipitación pluvial es alta, revisten sin embargo una importancia extraordinaria debido a la regulación de las aguas. Cuando están localizados cercanos a los centros de población, alcanzan una importancia especial como áreas para parques, recreación, casas de verano y hoteles.

El Bosque Subtropical Húmedo

Contiene una flora típica especialmente diversas especies de las Myrtaceae de los géneros *Eugenia* y *Myrcia*. En general, la asociación está compuesta por especies de hojas pequeñas y el bosque natural tiene poca importancia para la producción de madera. Dentro de esta zona de vida, la mayor parte del bosque original ha sido cortado para establecer plantaciones de café y otros cultivos.

El Bosque Subtropical muy Húmedo

Es más alto, más denso, que en la formación precedente con muchos representantes de las familias Rubiaceae, Melastomaceae y Lauraceae, y los géneros *Laplacea*, *Brunellia*, *Inga* spp., *Calophyllum*, *Taonabo*, *Ouratea*, etc.

En la zona de Cerro Azul nos adentramos hacia más allá de Loma Pelado, donde la vegetación se acerca a la de la formación bosque subtropical pluvial. Aquí encontramos *Podocarpus*, *Alfaroa* y *Quercus*.

Como indicado por las cumbres de las colinas, donde la vegetación es baja y poco densa, la pérdida del suelo debido a las lluvias excesivas, es muy pronunciada. Una vez que el bosque natural original de gran tamaño se corta de las vertientes, ocurrirá el mismo proceso de deterioración de los suelos. De esta manera la vegetación natural indica muy claramente que estas zonas no son apropiadas para la agricultura.

El Bosque Montano Bajo

En la provincia de Chiriquí, se caracteriza por *Persea schiedeana* Nees, *Quercus copeyensis*, *Weinmania pinnata* L. y *Cedrela tonduzii*. Hay diversas especies maderables y los árboles alcanzan grandes dimensiones con altos volúmenes por unidad de superficie. En la región, se pueden hacer pastos excelentes con la yerba kikuyu, *Pennisetum clandestinum* Choiv. pero la mayor parte del terreno de esta formación es realmente demasiado inclinado para la agricultura. Tanto este bosque como la formación montano que se encuentra más arriba y la que solamente se visitó por muy corto tiempo, son de suma importancia para la regulación de las corrientes de aguas que bajan de las montañas.

Uso Futuro de los Recursos

Como se ha mencionado previamente, la población actual de cerca de un millón de habitantes, solamente ha realizado ligeras incursiones en los recursos naturales de la República hasta la fecha. Esto resulta todavía más evidente por cuanto un número considerable de personas que viven cerca de la Zona del Canal, derivan sus ingresos de servicios y operaciones comerciales que no afectan los recursos de la República.

Sin embargo el aumento, duplicación, triplicación, etc., de la población que ha de producirse durante el próximo siglo, está destinado a producir tremendos cambios y significaría un impacto terrible sobre los recursos naturales de Panamá. Para los dirigentes gubernamentales debe ser deprimente constatar que a pesar de todo el despliegue de recursos

naturales, a saber, terrenos fértiles, exceso de maderas valiosas, agua y vida silvestre abundantes, tantas familias actualmente viven solamente, a un nivel muy bajo de subsistencia. Este tipo de agricultura primitivo de subsistencia destruye las riquezas potenciales sin beneficio alguno para el país y solamente parece conducir a un número, rápidamente creciente, de unidades familiares adicionales, responsables de posteriores destrucciones, en escala aún más rápida y más extendida. No existe duda de que el uso de los recursos naturales disponibles constituye un reto para la población de Panamá y sus dirigentes. Las normas que se siguen en el uso de los recursos dentro de las próximas décadas determinan si los panameños han de disfrutar de una vida rica y feliz, en armonía con su medio ambiente o si han de desperdiciar sus riquezas naturales u originar otro de esos "países pobres" del trópico, solamente de un bajo nivel de subsistencia.

Así, Panamá está frente a dos problemas distintos pero relacionados: debe elevar los actuales niveles de vida de la población existente y debe planificar el uso futuro para no solamente mantener sino también mejorar cualesquieras beneficios logrados calculando con un aumento contínuo de la población. A fín de poder realizar ésto, los habitantes de Panamá deben comprender cabalmente la naturaleza de sus recursos renovables y saber como usarlos propiamente a fin de mantener o mejorar su productividad.

De los recursos básicos, el suelo que en forma directa o indirecta permite la vida animal o vegetal, es el más importante. Panamá posee suficientes extensiones de terrenos planos o ligeramente inclinados, con textura física y composición química apropiadas, para abastecer sus necesidades agrícolas aún con un excedente apreciable para la exportación. Esto puede lograrse sobre la base de una producción contínua y para una población varias veces duplicada. Todos los esfuerzos agrícolas presentes deben concentrarse sobre estos terrenos, puesto que es perfectamente factible mejorar las cosechas y las técnicas agrícolas y elevar la producción a un nivel mucho mayor, como ya se ha demostrado en escala pequeña en determinadas zonas.

Por otra parte, no debe permitirse que nuevos desmontes con fines agrícolas progresen en aquellos terrenos de topografía accidentada o de baja fertilidad, ya que estos suelos son incapaces de mantener una agricultura estable y de alto nivel. Esto solamente puede conducir a futuros problemas sociales y económicos indeseables y además, debido a la alteración producida en el régimen de las aguas y la erosión, constituye una grave y permanente amenaza para los terrenos agrícolas permanentes y de alta calidad, situados más abajo, debido a la amenaza de posibles inundaciones o la escacez de agua para la irrigación. Además, estos terrenos, antes de su devastación, hubieran pondido tener un valor potencial mucho mayor para otros usos, tales como, para la producción de maderas o para esparcimiento de las poblaciones, sin menoscabo de los valores y efectos benéficos que siguen obteniéndose en relación con la regulación de las aguas y la protección de la vida silvestre.

Unos ejemplos específicos de lo que debe estimularse y lo que debe evitarse, pueden encontrarse fácilmente en Panamá. Algunas de las plantaciones de arroz que se encuentran a lo largo del ferrocarril entre David y Concepción, en la provincia de Chiriquí, demuestran muy bien con su alto grado de mecanización, que el hombre puede producir efectivamente un sobrante en alimentos, al usar los métodos correctos en las zonas apropiadas. Dentro de la misma región, las plantaciones de bananos cerca de Armuelles demuestran ampliamente la formidable productividad que es posible alcanzar mediante el buen manejo de la tierra y el empleo de técnicas adelantadas. Los cultivos de hortaliza de los chinos cerca de la Zona del Canal, demuestran claramente lo que puede lograrse con el manejo intenso y el trato cuidadoso de los suelos.

En el otro lado de la balanza, podrían citarse numerosos casos de esfuerzos mal dirigidos, originando perjuicios o representando

pérdidas económicas para la nación. El desmonte de magníficos rodales de árboles valiosos sobre las colinas de la provincia del Darién para la producción solamente de una o dos cosechas de granos, constituye un buen ejemplo de despilfarro de los recursos naturales y pérdidas económicas para la nación.

En la zona de Cerro Azul, a solo unos pocos kilómetros por carretera de la ciudad de Panamá, las colinas se elevan hasta el aire fresco de la faja subtropical. Aquí crecen bosques pintorescos y se aprecian magníficos panoramas de los terrenos bajos circundantes hasta y más allá de la ciudad de Panamá, así como de la costa y el Océano Pacífico. Toda esta zona del subtrópico, tan cercana a la capital, ya que se puede llegar allí muy rápidamente, posee un valor inestimable para recreación y descanso, lejos de calor y del ruido de la ciudad. Toda el área debería dedicarse para futuras casas de verano y parques públicos. Pero al contrario, con la apertura de carreteras, existe actualmente un intento siempre mayor para desarrollar el área para la agricultura con plantaciones de café y acondicionamiento de pastos para la ganadería, lo que disminuye enormemente los valores recreativos actuales. Esto constituye un caso obvio de falta de una planificación a largo plazo y de uso irracional de la tierra, puesto que además del alto valor recreativo que se pierde, la vegetación indica claramente que la zona no es apropiada para una agricultura lucrativa a largo plazo.

Recientemente se han hecho esfuerzos considerables en levantamientos y estudios de algunas áreas con suelos de baja fertilidad en Coclé y las provincias panameñas del suroeste, las que ofrecen pocas posibilidades de mejorarse económicamente. Nos parece que en vista del número limitado de técnicos en suelos que se disponen, los esfuerzos deberían de concentrarse primero en las áreas de suelos de producción potencialmente alta, tales como los que se encuentran al sur y suroeste de Concepción en la provincia de Chiriquí o en algunos otros terrenos llanos mencionados anteriormente.

Las llanuras bajas, con su riqueza intrínseca y su adaptabilidad a la mecanización, no solamente representan una alta productividad en relación con el hombre que los trabaja y por lo tanto niveles de vida potencialmente altos para los agricultores, pero también ofrecen las mejores perspectivas de conseguir buenas cosechas y adaptar técnicas agrícolas más productivas. Tales zonas agrícolas pueden desarrollar y mantener eficientes redes de carreteras, sistemas de educación avanzados, buenas facilidades de alojamiento y altos niveles de salud. Por su alta productividad por unidad de superficie y por hombre, estos terrenos agrícolas pueden desempeñar un papel muy importante para reducir la presión sobre los terrenos impropios para la agricultura y librar así una proporción considerable de trabajadores del país para que puedan ser aprovechados en el desarrollo de la industrialización. La expansión del cultivo del arroz de irrigación, debería de considerarse en vista del alto rendimiento que se obtiene por unidad de superficie.

Al igual que para la producción agrícola, una industria ganadera basada sobre el uso de extensas zonas de terrenos pobres con ganado mediocre y mano de obra barata, puede proporcionar buenas ganancias para unas cuantas familias de grandes terratenientes, pero contribuye muy poco a elevar el nivel general de vida o a la prosperidad del país. Un desarrollo satisfactorio debe basarse en el uso intenso de la tierra dentro de zonas apropiadas, conjuntamente con los esfuerzos tendientes a mejorar el ganado y los pastos. Existen ejemplos de tales ganaderías progresistas en Panamá, los que demuestran ampliamente que tales desarrollos son posibles y lucrativos. Además esta intensificación debe estimularse a fín de prevenir futuras expansiones de la industria ganadera hacia nuevas tierras inaptas para la ganadería y decididament inapropiadas para el pastoreo. Como ya se mencionó anteriormente, aún cuando dichas tierras puedan producir ganancias para una familia, esto solamente se lograría a expensas de un nivel de vida bajo y poco satisfactorio para muchas otras familias de

trabajadores, una condición poco convincente cuando la prosperidad general y el bienestar de todo un país están en juego.

El actual destino de los terrenos llanos y fértiles, tanto para cultivos como para la ganadería, todavía depende en gran parte de las preferencias personales de sus dueños. Los adelantos técnicos que han de realizarse en estos campos, deberían de conducir a una asignación económicamente más deseable de las tierras, tendiente a lograr la mejor utilización posible. Parece que actualmente existe una corriente muy saludable en este sentido, como puede observarse por ejemplo al este de la ciudad de Panamá hacia Chepo, donde algunas tierras planas facilmente mecanizables y que antes se utilizaban para la ganadería están siendo segregadas y convertidas a la producción agrícola.

Aparte de las condiciones sobre economía y mercados, que sin duda tienen su importancia particular en la selección de los cultivos, también la distribución y la superficie disponible de los suelos de alta calidad, deberían de considerarse a la luz de las zonas de vida o formaciones. Como un ejemplo de ésto, la formación bosque subtropical húmedo representa el clima ideal para *Coffea arabica* L. pero esta planta también se produce satisfactoriamente sobre suelos volcánicos recientes de la formación bosque subtropical muy húmedo. En Panamá, la superficie disponible para expandir el cultivo del café, es bastante limitada. Pero resulta que el café ha sido extendido fuera de sus límites climatológicos y sobre suelos que no serán altamente productivos. Las inversiones de capital en un cultivo, que se encuentra fuera de sus condiciones óptimas, tiende a detener el progreso general. En primer lugar, este mismo capital hubiera podido invertirse en una forma más productiva y trae por consecuencia la oposición de los terratenientes propietarios a los aumentos en salarios y niveles de vida de los trabajadores agrícolas, ya que esto arruinaría automáticamente sus operaciones en terrenos marginales.

En vista de que el cacao constituye un cultivo excelente para el bosque tropical húmedo y puesto que grandes extensiones de suelos aluviales fértiles pueden encontrarse dentro de esta zona de vida, parece mucho más deseable, en contraste con el café, estimular las inversiones a fin de expandir las plantaciones de este cultivo en Panamá. Como ha sido demostrado por investigaciones recientes, el cultivo del cacao también puede mejorarse técnicamente en numerosos aspectos cuando se consideran las prácticas actualmente en uso.

Como regla general, y mientras no se realicen muchas más investigaciones sobre el manejo de suelos tropicales y en la técnica agrícola resulta más prudente seguir las indicaciones de la naturaleza y evitar los intentos de producir cosechas donde es de esperarse más problemas que los normales. El bosque tropical húmedo es esencialmente un clima para árboles y los mejores resultados deben esperarse con cultivos tales como cacao, bananos, plátanos, caucho, palmas de aceite, abacá y otros del mismo grupo. En la formación bosque tropical seco, los cultivos de granos y el mantenimiento de pastos resultan mucho más sencillos. En Panamá, dentro de esta formación pueden encontrarse las mejores condiciones para producir arroz en secano, maíz, algodón, caña, ajonjolí, ganado para carne y frutas tropicales, tales como, mangos, aguacates, nísperos, caimitos, etc. Cuando las tierras llanas y fértiles pueden irrigarse, las posibilidades de producción son sumamente favorables.

Las formaciones montañosas, con la excepción de los terrenos que se encuentran en los valles planos o de suaves pendientes, deberían de reservarse permanentemente para bosques. En un futuro muy cercano, Panamá debería vedar tales áreas montañosas a la expansión agrícola y declarar estas reservas como bosques nacionales. Luego, dichas reservas pueden estudiarse más en detalle, segregarse y clasificarse en bosques productivos, parques nacionales, refugios de vida silvestre, etc. de acuerdo con el uso más ventajoso. Actualmente la creación de dichas reservas resulta fácil desde el punto de vista jurídico

y político, pero si se pospone y numerosas personas se establecen en ellas como colonos, habrá que confrontar toda una serie de problemas adicionales.

Como se ha destacado anteriormente, estas tierras no permiten el establecimiento una agricultura permanente con un nivel de vida satisfactorio, de manera que su prohibición para la agricultura a este respecto, responde a los mejores intereses de la nación.

Además, su protección constituye una garantía contra inundaciones desastrosas y asegura un abastecimiento adecuado de agua para la irrigación y para desarrollar energía hidroeléctrica, garantizando así una mayor estabilidad para las zonas agrícolas muy productivas que se encuentran más abajo. Finalmente adquieren con el tiempo una importancia vada vez mayor para el esparcimiento de las poblaciones y la producción de maderas.

Darién

La provincia del Darién se considera lo suficientemente distinta y tan poco afectada por el hombre hasta la fecha como para merecer un tratamiento separado en este informe. Como puede apreciarse en el mapa, la mayor parte de los terrenos bajos caen dentro de la formación bosque tropical húmedo, pero como el promedio de precipitación anual se encuentra tan cerca de los 2.000 milímetros u 80 pulgadas, límite aproximado de esta formación con el bosque tropical seco, hemos juzgado necesario delimitar una extensa región por separado como zona de transición. También en torno de la ensenada de Garachiné y en las cuencas superiores de los ríos Sabana y Chucunaque, se encuentra un bosque seco de tipo transicional, aun cuando en la primera zona, en las áreas de suelos arenosos y afloramientos de corales calcáreos, la vegetación parece indicar a primera vista, una precipitación todavía más baja. A lo largo de la costa del Pacífico hacia el sur y la frontera colombiana, así como en San Blás, la lluvia aumenta y dá lugar a una típica formación de bosque húmedo, mientras que al subir de elevación, se encuentran extensiones considerables de la formación bosque subtropical muy húmedo y algunas áreas de bosque montano bajo muy húmedo.

La población actual del Darién está repartida en unas pocas ciudades o poblaciones a lo largo de la costa, los estuarios o los ríos, con algún desarrollo agrícola sobre los terrenos fértiles de aluvión cercanos al tráfico fluvial. Los bananos y plátanos parecen ser los cultivos comercialmente más importantes, los últimos siguiendo a menudo los bananos que son más susceptibles a las enfermedades. La mayor industria de la región es la explotación maderera cortándose trozas de maderas preciosas para la exportación hacia el centro de Panamá y para el extranjero, aun cuando algunos aserraderos elaboran maderas de diversas especies dentro de la misma provincia. Debido a la relativa poca intervención del hombre hasta la fecha, el Darién ofrece excelentes posibilidades para planificar cuidadosamente el uso futuro de sus recursos.

Los cinco hechos más significativos que han de considerarse en la planificación del Darién, son los siguientes: (1) el enorme desnivel entre las mareas altas y bajas, (2) las tierras ricas o suavemente inclinadas que se extienden desde el nivel donde llegan normalmente las mareas altas hasta las colinas, (3) las áreas de bosques pantanosos o afectados por la marea, con rodales homogéneos de una o pocas especies, (4) el enorme valor potencial de la madera en los bosques de las zonas más secas, donde hay tanta abundancia de maderas preciosas y (5) el amplio sistema natural de cursos de agua navegables que atraviesan este cúmulo de recursos. Las embarcaciones marítimas pueden entrar en el estuario del río Sabana y subir el río Tuira hasta Chepigana. Además, las fuertes mareas extienden su influencia hasta muy arriba de los ríos para provecho de las embarcaciones más pequeñas.

En esta región, el desarrollo agrícola sobre cualquier escala grande, aparece potencialmente a la vez prometedor y precario. Las tierras más prometedoras hasta el momento, son los terrenos aluviales o de pendiente muy suave, que se encuentran algo apartados de las orillas de los cursos de agua, cerca de las

colinas, allí donde las aguas de inundación producidas por una combinación de mareas altas y ríos llenos durante la estación de lluvias, no entran o no afectan significativamente el terreno. Estas áreas son poco usadas en la actualidad porque se encuentran demasiado alejadas del transporte fluvial usual.

Entre estas tierras y el nivel de las mareas altas corrientes, se encuentra una zona mucho más extensa y terrenos llanos con suelos aluviales fértiles que resultarían muy prometedores para la agricultura si fuera posible establecer medidas efectivas de control contra tra las inundaciones. Algunas partes de esta zona se utilizan actualmente para la agricultura, pero cuando ocasionalmente el agua sube a niveles anormales, toda la gente, junto con sus puercos y gallinas, deben retirarse a sus casas construídas sobre pilotes, y esperar a que las aguas vuelvan nuevamente a bajar. Tal sistema de agricultura restringe el número de cultivos y quizás hasta representa una invitación al desastre que puede producirse durante algún período excepcionalmente lluvioso.

Hoy, con la existencia de poderosas maquinarias para movimientos de tierras, no hay duda de que los ingenieros puedan proyectar y erigir un sistema de diques y drenaje, capaz de convertir extensas áreas en tierras agrícolas altamente productivas. Una ventaja adicional de tales terrenos represados sobre las áreas agrícolas corrientes, estriba en que las aguas de las inundaciones pueden ser desviadas en cualquier momento oportuno para depositar su capa fertilizante de aluvión sobre determinadas porciones. (Fig. 5 y 6)

Puesto que tal agricultura científica para el Darién muy probablemente tendrá que esperar algún tiempo, hasta tanto la expansión de la población y las necesidades mundiales se hagan más apremiantes, debe darse énfasis a los problemas actualmente existentes, pero en todo caso, al planificar el uso de la tierra, ésto no debe perderse de vista y no debe destruírse el potencial que permitiría dicha utilización planificada para el futuro. Bajo estas consideraciones, las áreas montañosas y regiones más húmedas que se encuentran en las cuencas superiores de los ríos del Darién, deberían de colocarse bajo reserva en un futuro cercano, a fin de evitar su utilización para la agricultura. Esto es por demás deseable por cuanto solamente una porción muy pequeña de los terrenos ofrece alguna promesa para una agricultura de alto nivel y cualesquiera deforestaciones en gran escala, resultarían en una escorrentía más violenta y niveles más altos en las inundaciones, destruyendo así el valor potencial de las llanuras aluviales que se encuentran más abajo.

El área muy quebrada que se encuentra en la parte superior del río Tuira y posiblemente diversas otras secciones de la provincia del Durién, muy bien podrían apartarse como parques nacionales. Los hermosos paisajes que se divisan navegando sobre el Tuira, con rocas imponentes a lo largo del río y el bosque natural muy atractivo, sin duda llegarán a constituir algún día una atracción poderosa para los turistas con solamente lograr mantener las condiciones naturales actualmente imperantes.

Por las mismas razones anteriormente enumeradas, no se considera deseable el desarrollo de la industria ganadera para el Darién. Aunque alguna finca ganadera existente haya dado buen resultado y tanto el clima como los suelos resulten evidentemente satisfactorios, cualquier extensión considerable de terreno para pastoreo, conduciría automáticamente al uso cada vez mayor del fuego y la destrucción de los bosques de las colinas. Es tan grande el valor potencial de las llanuras aluviales para una agricultura mixta, que no debe permitirse que la agricultura nómada en las cabeceras y el postoreo en escala grande, puedan constituir una amenaza para tal uso futuro.

De todo el territorio de Panamá, la provincia del Darién ofrece oportunidades excepcionalmente favorables para el manejo productivo de los bosques y la industrialización de los productos forestales.

Fig. 5:—La deforestación de los terrenos marginales en las orillas de los ríos del Darién, es un espectáculo común.

Fig. 6.—En las cuencas superiores de los ríos del Darién se divisan magníficos panoramas. Algún día éstos constituirán una legítima riqueza panameña para fomento del turismo, la caza y la pesca, así como otras actividades recreativas sin mencionar todos los valores protectores... si para entonces han logrado conservarse en su estado natural.

La extensa red interna de comunicaciones fluviales, los rodales puros de bosques influenciados por la marea y la presencia de maderas de alta calidad en los bosques más secos, los tres factores se combinan aquí en una forma perfecta que muy raras veces se encuentra en las Américas.

La explotación actual de los bosques del Darién es de tipo mas bien destructivo en cuanto a los recursos forestales y poco contribuye al desarrollo de la provincia. En los manglares, los árboles se tumban para aprovechar su corteza solamente, dejando que los troncos enteros se pudran en el suelo. En los bosques heterogéneos, las operaciones madereras generalmente solo extraen una o dos especies tales como la caoba y el cedro amargo. Además, solo aprovechan los troncos rectos o una parte del árbol. No se piensa en el futuro del bosque.

Aquí nos encontramos con un caso claro donde la combinación ventajosa de los recursos forestales ofrece la posibilidad de una industrialización integral para beneficio realmente permanente, tanto para la provincia como para la República de Panamá. Muy bien podrán combinarse el capital panameño con capitales y conocimientos industriales técnicos del extranjero, para beneficio mutuo. En el presente, tres tipos de procesos industriales parecen ofrecer excelentes oportunidades.

El primero de éstos es una planta para enchapado o maderas laminadas, a base de las maderas preciosas apropiadas para vistas o caras exteriores, abundantemente representadas en el Darién, al igual que las maderas menos valiosas que han de servir para interiores o rellenos. Una planta para enchapado que se encuentra cerca de la ciudad de Panamá, ha estado operando con maderas traídas del Darién aunque resulta difícil comprender las posibles ventajas —si acaso las hubiese— que existieron para escoger este sitio en relación con la procedencia de la materia prima.

También puede pensarse en otro tipo de industria o muy bien combinarlo con la planta de enchapado y los aserraderos. Es la que se basa sobra el proceso "Novapan"? desarrollado en la Suiza. En este proceso, se elaboran artificialmente las tablas con pedacitos de madera sobre la base del mismo principio que la industria del enchapado, en el sentido de que una madera inferior se usa para la mayor parte de la tabla, mientras que ambas caras o vistas se cubren con láminas de maderas de grano o color mucho más atractivo. Puesto que toda la madera en este proceso se reduce a pedacitos o virutas, es posible obtener buenas cantidades de materia prima para las vistas a base, por lo menos, de lo que normalmente se abandona en el bosque, tales como troncos cortos o ramas gruesas o lo que se desperdicia en condiciones normales en el aserradero o la planta de enchapado. La madera procesada o los pedacitos luego se mezclan con cola y se prensan en forma de tablas o productos similares. Este proceso ofrece la ventaja de que se pueden agregar productos químicos para evitar tales factores deteriorantes como los daños causados por los termitas. Además, por el hecho de poder utilizar tanto desperdicio, ha de ser altamente recomendado para dicha integración industrial.

Un tercer proceso de fabricación de tablas, consiste en reducir la madera de una o varias especies de maderas duras, hasta sus fibras, al igual que en el proceso de fabricación de la pulpa. La planta "Fibracel" que opera en Ciudad Valles, cerca de Tampico, México, es un ejemplo de esta industria. Dicha fábrica tal vez pueda utilizar maderas como mangle o alcornoque que se encuentra en rodales puros sobre extensas zonas, cerca de las vías acuáticas. Cualquier empleo de la madera del mangle rojo que podría combinarse con la extracción de la corteza para tanino, sería altamente deseable.

Una vez que la industrialización de los recursos madereros del Darién esté encaminada, los sistemas de transporte desarrollados permitirían la explotación y el embarque de muchas otras maderas especiales. También es muy probable que se encuentren usos para algunas de las especies muy abundantes como el cuipo, y que hoy se consideran sin valor.

El desarrollo de la producción económica de pulpa y celulosa a partir de maderas tropicales, la producción de azúcar a partir de la celulosa de madera y la conversión de los azúcares de la madera en proteína con cultivos de levaduras, son algunos de los tantos procesos próximos en aplicarse y las fábricas no tardarán en establecerse allí donde las otras plantas industriales han mostrado el camino.

También se vislumbran otras posibilidades de uso más directo. Las trozas cortas o parcialmente huecas y las ramas gruesas de caoba u otras especies, podrían abastecer una fábrica de piezas para muebles, las que podrían exportarse desde la provincia como piezas sueltas, desarmadas. Durante nuestro recorrido, nos impresionó también la cantidad fabulosa de una palma nativa llamada "guáguara". Es una palma de caparazón muy dura con un tronco alto y muy recto y con un posible promedio de 6 a 8 pulgadas de diámetro. Nos parece que valdría la pena llevar a cabo algunos ensayos con esta palma para la exportación, a fin de utilizarla como poste de minas, en posición vertical. Parece particularmente apropiado para ello, pues también el aspecto económico de su extracción hasta los puntos de embarque resulta satisfactorio.

Resumen

Recapitulando brevemente, puede decirse que Panamá dispone de abundantes recursos naturales renovables, los que, cuando utilizados correctamente sobre una base racional, pueden desarrollar una enorme riqueza y un alto nivel general de vida, aun para una población mucho más numerosa. Sin embargo, para alcanzar esta utilización correcta se requiere una planificación cuidadosa y la educación de toda la población en el sabio uso de sus recursos. Los dirigentes gubernamentales y los financieros locales deben dirigir sus esfuerzos y su capital en aquellos proyectos y regiones que puedan ser desarrollados sobre una base permanente con posibilidades de ganancias no solamente para los dueños de la tierra y los capitalistas, pero que ofrezcan también una oportunidad de levantar los niveles de vida de todos los que trabajan en estos proyectos.

Una de las necesidades más apremiantes del país para lograr tal desarrollo planificado, son los técnicos locales dentro de los diferentes campos del uso de la tierra, a fin de llevar a cabo las investigaciones, servir de agentes de extensión o educadores y llenar las necesidades de técnicos o administradores en el campo. Todavía queda tiempo para hacer todo ésto, puesto que muchos de los recursos naturales se encuentran más o menos intactos pero el aplazamiento en el desarrollo del sabio uso de los recursos, a medida que la población crece a un ritmo vertiginoso, rendirá la tarea mucho más difícil o aún imposible de realizar dentro de unos cuantos años más.

En vista de que los terrenos y recursos forestales son tan vastos y tan prometedores, las posibilidades económicas para el desarrollo industrial forestal, una de las tareas inmediatas a realizar por parte del Gobierno de Panamá, sería la de adiestrar a técnicos forestales y establecer un servicio efectivo de bosques nacionales. Tal servicio debería emprender lo más pronto posible la reservación de los bosques y parques nacionales sobre extensas regiones en las zonas montañosas y quebradas y además realizar los estudios necesarios en aquellos bosques que ofrecen las mejores perspectivas de desarrollo industrial. Las industrias forestales al necesitar cuantiosas inversiones iniciales para su establecimiento, están interesadas en operaciones a largo plazo. Son por lo tanto deseables ya que tienden a mantener los bosques sobre una base de producción permanente y contribuyen a lograr un mejor nivel de vida para los habitantes.

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Report on the Fourth Tropical Forestry Short Course

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Introduction

The importance of forest resources to the economic and social development of a country becomes more apparent throughout the world day by day. With an increase in population comes an increase in demand for the products which forests can offer in perpetuity— WOOD, WATER, WILDLIFE, RECREATION, and FORAGE. This appreciation of the value of forests has resulted in a desire for additional knowledge on how forests can and should be managed and utilized to derive these multiple-use benefits.

The International Cooperation Administration and the Food and Agriculture Organization of the United Nations have, for several years, been assisting many countries throughout the world gain such knowledge. In order to systematize and give more effective training to foreign foresters, the U. S. Forest Service suggested that the ICA sponsor an organized short course in tropical forestry to be conducted by the Forest Service at the Tropical Forest Research Center in Río Piedras, Puerto Rico.

The first such short course held in 1955 proved so successful that three essentially similar programs have been given since. 1/. This brief report on the 1957 short course is written primarily for the information of those persons who are interested in personnel training and could be instrumental in sending men to attend similar courses which may be offered in the future. In this connection, the Tropical Forest Research Center would welcome comments and suggestions concerning the curriculum, particularly from those who have administrative or technical responsibility for forestry programs and practices in tropical countries, and from those who have had the opportunity to observe the work of course participants after they returned to their work.

1/ A Report on the Tropical Forestry Short Course held in Puerto Rico, March 1 to May 29, 1955. Frank H. Wadsworth, B. J. Huckenpahler, and Carl F. Ehelebe, Caribbean Forester 16 (1 & 2): 12-23.

The 1957 Tropical Forestry Short Course

Sponsorship and Cooperation

The International Cooperation Administration through its Overseas Missions recruited all the trainees and financed their travel and subsistance with one exception. The participant from Liberia was financed completely by his government. Through regular allotments to the Forest Service for foreign training or through specifically allocated funds for the course, ICA financed local costs of instructors, administration, and transportation, including the entire costs of two of the three visiting instructors. In addition, ICA paid for most of the aproximately 300 publications, charts, and other training items furnished each student.

The Food and Agriculture Organization of the United Nations cooperated by sending an instructor for the final two weeks and contributed many publications dealing with various tropical forestry problems throughout the world.

The administration and conduct of the course was under the direction of the Tropical Forest Research Center. The Office of Technical Cooperation, P. R. Department of State, assisted in the physical arrangements and orientation. During the course of

instruction, the Forest Service was assisted by several other agencies of the Commonwealth of Puerto Rico particularly the Division of Forests, Fisheries, and Wildlife of the Department of Agriculture and Commerce, and the Agricultural Extension Service and Agricultural Experiment Station of the University of Puerto Rico. Other federal agencies in Puerto Rico assisting were the Soil Conservation Service and the Agricultural Stabilization and Conservation Service, both of the Department of Agriculture.

Objectives and Scope

The course was planned to offer through a balanced program of lectures, training films, and field work, a comprehensive coverage of most branches of forestry and types of forestry programs. Its primary purpose was to provide an opportunity for practicing foresters from tropical countries to study basic scientific principles, and to observe and learn to apply some of the practices, procedures, and techniques necessary for the proper administration, management, ,and utilization of forests. The training was designed also to touch upon other phases of natural resource management particularly as they affect land use, soil conservation, and watershed protection.

Facilities and Student Accomodations

The lectures, discussions, and showings of training films were held in the library of the Forest Service headquarters building in Río Piedras. The experimental nursery, herbarium, and wood laboratory at the headquarters were also utilized. The group included both English and Spanish speaking students so the instruction was given in both languages. The translating was done by members of the research center staff. Most of the important information not available in publications, and some of the lectures were mimeographed, wherever possible in both languages. Most of the printed publications were available only in English though some, especially those published by FAO, were available in English and Spanish. Including the mimeographed material , more than 300 different items were supplied to each trainee. Twenty-two training films were shown.

Most of the field studies and practical exercises were carried out on public lands within two Federal and five Commonwealth Forests utilizing to their fullest advantage, permanent sample plots where various practices and techniques are being tested and demonstrated. The commonwealth forest tree nursery was also used during the session devoted to nursery work. Approximately 40 percent of the time was devoted to field and laboratory work.

Due to the concentration of university-students in Rio Piedras, satisfactory living accomodations for short-term students are difficult to obtain. In order to assure desirable quarters at reasonable rates, and to house the students at one central location convenient to the Forest Service headquarters, the Forest Service contracted for three apartments in an apartment-hotel located within walking distance from headquarters. Each apartment consisted of a small kitchen, a large living room, a small bedroom and bath. Apartments were furnished except for stove and refrigerator, by the Forest Service. Four students lived in each apartment. One group began to cook their own meals as soon as they moved in; by the time the course ended, only three men were eating out.

Instructors

The major portion of the instruction, both in the classroom and in the field, was given by personnel of the Research Center stationed in Puerto Rico. Members of the Commonwealth Division of Forests, Fisheries, and Wildlife gave considerable assistance particularly when work in regeneration and silviculture involved trips to the nursery and

Commonwealth Forests. A number of instructors were, however, brought from outside Puerto Rico to give the course participants the benefit of instruction by men who are specialists in their field or have had wide experience in tropical forestry matters.

Mr. Floyd M. Cossitt, Division of State and Private Forestry, Southeast Region, U.S. Forest Service, directed a comprehensive program on nursery work and planting based on our 30-year experience in these subjects.

Mr. Earl J. Rogers, Division of Forest Economics Research, Washington Office, U.S. Forest Service with experience in Peru and Formosa, presented the latest developments in the application of aerial photo interpretation to forest resource surveys and other mensurational techniques.

Mr. A. Hyndman Stein, Food and Agriculture Organization, United Nations, led the the sessions on forest policy and legislation and the round table presentation of forest conditions, problems, and programs in participants countries. He also assisted during the specialization period during the last week. Mr. Stein has had nearly 35-year experience in India, Iran and Chile. He is now at the Inter American Institute of Agricultural Sciences, Turrialba, Costa Rica.

Trainees

The course announcement stated the following qualifications for participation, "This training program will be available to persons recommended by authorized officials of the sponsoring agencies on the basis of education, training experience, and present position. All candidates will be expected to have an active professional interest in certain major aspects of tropical forestry, as well as a desire to expand their technical training and thereby be able to more effectively carry out their official responsibilities in their respective countries. Preferably the candidates will be graduate engineer-agronomists with some forestry training and experience or graduates of secondary or technical school with a minimum of 4 years forestry experience. They should be performing duties and have responsibilities comparable to the ranger or supervisor level."

Eleven trainees attended the course. The name, position, and home country of each is as follows:

Besnett Chelmsford Halley - British Guiana
Forest Ranger, Forest Department

Alberto Burela Suárez - Bolivia
Agricultural Technician, Servicio Agrícola Inter-Americano

J. Hipólito Camargo B. - Colombia
Forester, Servicio Técnico Agrícola Colombiano Americano

Amílcar Arturo López M. - Colombia
Extension Forester, Servicio Técnico Agrícola Colombiano Americano

Carlos Luis Lizano P. - Costa Rica
Chief, Forest Management Section, Department of Forestry

J. Antonio Beteta Martínez - Guatemala
Forestry Zone Chief

Anthony Tieh Sayeh - Liberia
Forestry Aid, Department of Agriculture and Commerce

Francisco Cornejo - Panamá
Chief, Forestry Office, Ministry of Agriculture

George Durrant Glasgow - St. Lucia
Forest Ranger, Forest Department

Dusit Banijbatana - Thailand
Chief, Division of Working Plans, Department of Forestry

Adelbert Edward Smith - Trinidad
Forest Supervisor, Forest Department

Subject Matter and General Program

As mentioned previously, the course was designed to cover, although very briefly in some cases, all broad subjects in the field of forestry. The initial questionnaire filled out

Participants - Fourth Tropical Forestry Short Course, 1957

Front, left to right

George Durrant Glasgow - St. Lucia
Adelbert Edward Smith - Trinidad
Anthony Tieh Sayeh - Liberia
Besnett Chelmsford Halley - Br. Guiana
J. Hipólito Camargo B. - Colombia
Amilcar Arturo López - Colombia

Rear, left to right

Dusit Banijbatana - Thailand
Alberto Burela Suárez - Bolivia
Francisco Cornejo - Panamá
J. Antonio Beteta Martínez - Guatemala
Carlos Luis Lizano P. - Costa Rica

by the students led to the conclusions that this would be the best approach and no changes in the planned program were made. The time, both classroom and field, devoted to each broad subject was as follows:

SUBJECT	Days Allotted: Lecture	Days Allotted: Field or Laboratory
Orientation	2	—
Dendrology	½	1
Ecology	½	1
Artificial Regeneration	4½	2½
Silvics and Silviculture	1	4
Forest Mensuration	5	4
Forest Research	2	1
Forest Utilization	3	2
Forest Protection	1	—
Public Forestry Programs	2	—
Private Forestry	1	—
Agric. Research and Extension	½	½
Soil Conservation	—	1
Allied Natural Resources	—	5
Forest Policy and Legislation	1	—
Forestry in Participants Countries	4	—
Specialization	4	—
Totals	32	22

The general training program was as follows:

March 13-15

Physical Arrangements and Orientation.—Preview of the training course, description of forestry, agriculture and education in Puerto Rico. Social, economic, and industrial development of the island and its people.

March 18

Dendrology and Ecology.—Lectures and laboratory work on the classification of trees, nomenclature keys, collection and preservation of specimens etc. Lectures on plant associations, vegetative formations, and forest types.

March 19

Dendrology.—Field trip to Luquillo experimental forest on tree identification and classification.

March 20

Ecology.—Field study of plant associations and forest types in the Luquillo experimental forest.

March 21-29

Artificial Regeneration.—Lectures, training films, laboratory work and field study. Planning a regeneration program; seed collection, storage, sampling and testing; nursery planning and construction; nursery soil preparation, sowing, weeding and watering; control of nursery insect and disease pests; lifting, grading, packing, potting and transplanting seedlings; storage and transportation of seedlings; practice seeding; direct seeding in the field; vegetative propagation; planting problems, plans and surveys; planting tools, techniques, and practices; field study of test plantations; and practice planting.

April 1-5

Silvics and Silviculture.—Lectures, field study and practical work. Tropical silvicultural systems; intermediate cultural cuttings and other cultural operations; field study of growth plots; practice marking for stand improvement; and field study of thinned plantations.

April 8-18

Forest Mensuration.—Lectures, training films, laboratory and field work. Interpretation of aerial photographs in mapping, and

planning and conducting forest resource surveys; use of the stereoscope in volume determination from photographs; timber cruising methods and procedures; volume table construction and use; log and tree grading, log scaling use of technical tools and equipment; and analysis of data.

April 22-24

Forest Research.—Lecture, training films, and field study. Planning and research program; program and problem analyses; preparation of study plans and reports; research techniques and procedures; discussion of representative experiments; and field study of experimental plots.

April 25 - May 1

Forest Utilization.—Lectures, training films, laboratory exercises and visits to wood using industries. Uses of wood; moisture content, specific gravity, and density; physical properties and machining of wood; air seasoning and kiln drying practices; growth-structure relationships; relationship between forest management and utilization; logging and sawmilling; derived products and utilization of wood waste; wood preservation practices and techniques; and visits to furniture factory, paper mill, and corrugated box plant.

May 2

Forest Protection.—Lectures and training films on the protection of forest resources against damage by fire, insects, and diseases.

May 3-6

Public Forestry.—Lectures, training films, and discussions. The application of the principle of multiple use to management of public forests and wild lands; organization, administration, and activities including timber sales, watershed management, recreation and wildlife, of the U. S. Forest Service; and information and education programs.

May 7

Private Forestry.—Lectures, training films, and discussions. State and private forestry in the U. S.; industrial forestry and tree farming; and a round table presentation of public aids to private forestry.

May 8

Agriculture Extension and Research.—Lectures and discussions on programs and methods of the Extension Service and Experiment Station of the University of Puerto Rico.

May 9

Soil Conservation.—Field trip to observe and study soil conservation problems and practices employed in the action program of the Soil Conservation Service of the U. S. Department of Agriculture.

May 13-17

Allied Natural Resources.—Field trip to visit projects and discuss the programs concerned with or dependent upon the conservation of forest, soil, and water resources. Watershed management, hydroelectric power generation and irrigation reservoirs; recreation and fish and game management; and special uses in public forests.

May 20

Forest Policy and Legislation.—Lectures and discussions on the principles governing the formulation of basic forest policy and the elements of good legislation affecting forest, soil, and water resources.

May 21-24

Forestry in Participants' Countries.—Presentation by the participants and round table discussion of a description of the forest conditions, problems, and programs in the countries represented.

May 27-31

Specialization.—Time devoted to lectures, consultations, library, and or field work on special elective problems on which participants wanted additional information. Additional instruction of from one-half to one and one-half day was given in nine subjects.

SUBJECT	Number of men	Number of days
Volume Table Construction	4	1½
Organization & Administrative Management	5	1½
Watershed Management	5	1
Variable Plot Radius Cruising	11	½
Forest Management	11	1
Forest Research	4	1
Use of Technical Equipment	2	1
Nursery and Planting	1	1½
Fiscal Procedures	2	½

A highlight of the program was the presentation by each participant, of information concerning the forest conditions, problems, and programs in his country, the discussions and the summary that followed these presentations.

Fifty—four days were actually spent in training; 60 percent in the classroom and the remainder in the field or laboratory. Students spent 594 mandays and covered 13,200 man-miles in training without an accident and with only two man-days lost through illness.

Professionally and sociologically the course was a success. The students gained much new technical information concerning all phases of forestry, learned about the status of association between the United States and Puerto Rico, and at the same time through association with each other, learned something of the life and customs in the various countries represented.

Forest Conditions and Problems in Participants' Countries [1]

A. H. STEIN, FAO Forester
Inter-American Institute of
Agricultural Sciences
Turrialba, Costa Rica

During the past few days the representative from each country has given a most interesting description of the forest conditions and problems in his respective country. Though there may be wide variations from country to country in those conditions and the methods of solving those problems, we shall probably all agree on one point, that not one of them, in following the profession of forestry, need have a life devoid of interest.

In making a very general review of the complete detailed material which was presented, perhaps a few remarks on the following five points may be helpful: (1) area, (2) distribution, (3) policy and ownership, (4) silvicultural treatment, and (5) utilization.

Area

In comparison with many temperate and a few tropical countries the proportion of forest to the total area of the countries represented is generally adequate, considering each country as a whole. With the exception of St. Lucía, which has only 13 to 14 percent, the proportion is 40 percent or more, ranging from 40 percent in Bolivia to 83 percent in British Guiana. Most countries, therefore, are fortunate in this respect. No forester can, however, find satisfaction in the mere extent of the forests of his country unless their security is assured by a forest policy which provides either for the reservation under state ownership or the permanency of forests in private ownership, the minimum area considered desirable for protection and production. As we have seen, populations are increasing fast in some countries, Colombia and Costa Rica being specially notable, both having had a population increase of about 25 percent in the past 6 years. In other countries there have been great development of communications and more will take place in the near future, such as the construction of the Pan American highway in the Darien tract of Panamá, and roads across the island of St. Lucia. Such developments may be expected to make a greater demand on the available land for agriculture, to bring about possible changes of land use, and to increase the possibilities of utilization of forest products. It is important that each country should have a forward policy and take action *now* to be ready to face these eventualities with equanimity. Protection of the forest resources of a country against fire, and reservation of the minimum area considered essential for protection of soil and water resources, should be considered as first objectives if these have not been secured already.

Distribution

Though the extent of forest area, considering the country as a whole, is generally adequate, and the distribution of forest is generally such that populations can satisfy their demands for forest products without serious difficulty, there are certain areas which are deficient. This appears to be the case in areas such as the "altiplanos" of Bolivia and Colombia, and the intensely cultivated rice lands of Thailand. St. Lucia, even with a small population, has to import 500,000 board feet of coniferous timber

1/ Review of material presented by students attending the Tropical Forestry Short Course, March 13, - May 31, 1957, R. Piedras, Puerto Rico.

annually. The questions of how these deficient areas can be supplied with forest products, and how imports can be prevented by domestic production, are of special interest to foresters of these countries. The solution may be the improvement of communications to render existing forest tracts accessible, the reduction of waste in the exploitation of these. or the formation of plantations of fast growing species, making use of sites such as patches of uncultivable land, river banks, and road sides in agricultural tracts. There seems to be no reason why any country represented should be faced with the necessity to import timber as from the descriptions, the greater part of each country is well suited for forests. Plantations of fast growing species in agricultural tracts should be specially attractive to private initiative, since they offer prospects of quick returns.

Policy and Ownership

The Government of some countries is not yet prepared to declare a policy, and the general public of some is not yet fully forest conscious. The descriptions of British Guiana, Liberia, St. Lucia, and Trinidad indicate that those countries are comparatively fortunate in these directions. On the other hand, Thailand, with more than half a century's experience of national forestry has still to declare its national forest policy. Most countries in Central and South America, in which the need for scientific forestry is only now beginning to become prominent, have much progress to make. In such cases it is essential that the foresters should first make a detailed diagnosis of the reason and then begin a compaign of positive action to overcome those obstacles to forestry development.

The foresters may have to undertake a general forestry education program. The representative from Panama emphasized that forestry education and development of a forest conscience should precede forest policy and legislation before these can be effective.

An exposition of the direct financial benefits to be obtained by a national policy of conservation and management of the forest resources may be the first means of awaking the interest of Government in forest policy.

Governments are often hard pressed for funds and are likely to welcome prospects of this nature. The prospect of replacing imports by national production may appeal both on financial and patriotic reasons. However, no opportunity should be lost of emphasizing the indirect benefits of forests.

The development of facilities for recreation in the forests has great potentialities for educating the public and developing a forest conscience, and action to educate the public, being a more personal approach, may be more productive of quick results. Apart from appealing to the national pride, recreation forests may often be self supporting and therefore are not necessarily dependent on general funds. In some countries such as Denmark, even private proprietors have found that the opening of their forests to the public for recreation can be a financial help.

The inadequacy of funds appears to be a problem common to all countries described. When there is a national forest service, it is reasonable to expect that a certain portion of the national budget should be allocated for its expenses. If the funds allocated are inadequate, the national forest service has to make out a convincing case for more. However, the national budget is not the only source. Forestry developments can be financed by loans, forest reserve funds subscribed by private interests, or funds may be formed by trade. For example, the Lac Research Institute at Namkun, Ranchi in India had been financed by a voluntary cess on lac manufacturers and exporters, research on cacao is finaced by cocoa and chocolate manufacturers. In some countries forest or timber development associations have been formed to promote the interests of producers, commerce, and consumers.

The position regarding ownership of forests varies considerably. It is a matter for

each government to decide on the form of ownership most appropriate for its social and economic development. While State ownership of the minimum area of forest considered essential for protection is undoubtedly desirable ,there is nothing wrong about private ownership of forests required primarily for production, assuming the existence of a forest conscience and a willingness on the part of the owners to conform with a national forest policy. In the absence of these it may be necessary for the State to own also the minimum area of forests considered necessary for production.

As was pointed out by the representatives of Guatemala and Panama, there are populations whose customary methods of cultivation cause destruction of forests. It is however, impracticable and inhuman to prohibit such practices abruptly, or to compel the populations accustomed to highlands to migrate to lowlands where there may be more land available but where the people would have to live under completely different climatic conditions and follow different methods of cultivation. Such changes can only be introduced gradually. The degree of destruction of forests depends to a large extent on the population growth. So long as the population remains fairly stable, the forest destruction may be kept within reasonable limits. In the Guatemalan highlands the fact that the existing methods of agriculture have been practiced continuously for centuries indicates that they cannot be completely destructive. In fact, the rotational cultivation, terracing, and gully plugging to achieve torrent control which may be seen at some places, suggest a considerable knowledge of conservation practices. The true solution in such cases is to show the population how their present methods can be improved, perhaps by control of fire, control of grazing, and better forest use including the adoption of "taungya" to combine reforestation with cultivation of agricultural crops. Under such conditions forestry extension can perform a most useful function. In Central India, where vast tracts, populated only by forest tribes who practiced shifting cultivation, were reserved as State forests during the last century, this problem was overcome by allocating certain patches of cultivable land in the reserves for use as forest villages under the control of the Forest Service. The forest tribes were gradually settled on the forest villages within which they were given rights of cultivation. They also received certain concessions of timber, fuel, and grazing, and had first claim on employment on forest works. In some cases their assistance was useful when "taungya" was adopted for reforestation of the depleted forests. Later, as forest operations increased in intensity, these forest villages became the main source of labour and the Forest Service took over welfare activities such as the maintenance of schools.

Silvicultural Treatment

Apart from some local types as the coniferous forests on the Guatemalan highlands, and the steppe types on the altiplanos in Bolivia, the forests of the countries described fall into two broad types — the very humid tropical and the dry tropical.

The regeneration of the former is accompanied by a number of problems — the heterogeneous nature of the forests, the absence of demand for most species, and the small population resulting in a limited local demand and an inadequate labour supply. The methods which should be adopted to overcome those problems call for the attention of us all. Some schools of thought recommend wholesale removal of the natural forests and their replacement by man made forests composed of fast growing species of greater value. Other schools advocate the natural regeneration of the existing forests, at least of the most valuable species, by gradually lifting of the overhead canopy. Others consider the enrichment of the existing stand by the artificial introduction of valuable species. All involve considerable sacrifice of material, are

expensive, and call for an adequate labour supply. The latter is often a limiting factor.

Utilization

The descriptions show that there is still a great need for better methods of utilization in all countries. There is still waste in the exploitation of species at present considered valuable, and still greater waste in the case of species at present not considered to be of commercial value. The need for improved utilization undoubtedly calls for the closest possible attention of all foresters as a major contribution to the solution of many existing forest problems.

The representative of Trinidad suggested that charcoal making would be useful for reduction of waste. Charcoal making in forests covered by a sound policy or under a management plan, can be a most useful tool of silviculture and utilization as was found to be the case in the State forests of Central India which became the main source of supply of charcoal for Bombay City. On the other hand, in the case of forests not so far protected, charcoal making can become an evil causing widespread destruction. This was the case in the valuable broadleaved forests on the northern slopes of the Elbruz mountains in Iran, when these became accessible to Teheran, the capital of the country, situated on the southern treeless side of the range.

The representative from Guatemala mentioned that Forest Industrial Units had been or were to be formed in the Peten tract of his country. The development of integrated forest industries on a large scale may show the way to sustained yield management, judging from the progress made in this direction in recent years in the U. S. A., Canada, and Mexico. Cooperation between private owners at least as regards marketing, may be more difficult to achieve in practice, but would also be a most useful step towards reduction of waste and sustained yield management.

The descriptions show that in most countries, particularly in Thailand, minor forest products are extremely valuable. Tropical countries are generally fortunate in having forests which yield a great variety of minor products of economic value. The collection of these products either for local consumption or for sale may be of very great importance to the local population. The development of minor forest products in collaboration with the local population is likely to promote the development of a forest conscience and eventually the appreciation of the need of forests for protection and production.

Forest Conditions, Problems, and Programmes in British Guiana

V. VIEIRA and H. RICHARDSON 1/
Bristish Guiana

THE COUNTRY

Area and Population

The area of British Guiana is 83,000 square miles or 53,120,000 acres. The population is about 450,000; an average of only five and a fraction persons per square mile.

Land Use

Agriculture - About 1,500 square miles located along the entire coastal strip where the original swamp and marsh vegetation was destroyed through proper drainage and along the river banks for some miles inland. In savannah country, cultivation is restricted to the fertile valleys and hill slopes far from the settlements. The principal crops are sugar, rice, vegetables, coffee, and cocoa.

Forest. - About 70,000 square miles covering most of the land area and located in the immediate interior except for a portion in the northwest along the coast where there is mangrove (*Rhizophora mangle)* forest. The forest at present is mainly for commercial use and no attempt has yet been made to build recreation areas or parks. Portions of the area are naturally scenic and suitable for such where persons travel to from the noisy towns.

Other Lands. - Total 11,500 square miles. These consist primarily of mining and grazing lands in the deeper interior and savannahs respectively. Mining operations have done little damage to this forest and the total area affected is a very small proportion of the total forest area. Some of the principal mining products are bauxite, gold, diamonds, tantalite, columbite and other precious stones.

Physical Environment

Climate

The climate of British Guiana is tropical but pleasant. There are two wet and two dry seasons. The relative humidity is always high; the mean shade temperature remains remarkably constant. The northeast trade winds blow steadily for 9 months of the year.

Topography

British Guiana is situated in the north coast of South America and is shaped like an hour glass. It has a coast line of 270 miles and a maximum north-south depth of 540 miles. Four main topographical regions can be recognized:

Coastal Belt. - A region of low lying alluvium which still carries a complex series of swamp and marsh.

Lowlands. - An area of undulating land generally below 500 feet in elevation.

Pakaraima Mountain Region. - An elevated tableland rising to an altitude of 9,000 feet at Mt. Roraima.

Southern Uplands. - A region of undulating land generally above 500 feet in elevation.

1/ Respectively Forest Inspectar and Farester, Farestry Department, British Guiana. A paper presented while the authars participated in the third tropical farestry shart caurse, March 7 ta May 17, 1956, Ria Piedras, Puerta Rica.

Soil

The soil types tend to follow the main geological patern. Fertile clays from the coastal alluvium saturated with sea salts; infertile sands and loams from the white sand series and kaieturian sediments; loams, clays, and red earths from the Basement Rocks and later basic intrusives. Peat, locally termed "pegasse", is accumulated to a depth of 12 feet on the clay where a fresh water swamp is formed in the rear of a sand bank. Peat is found to a great extent in the Northwest District.

The normal gradation of soil from the watershed to valley bottom is white sand — light brown sand — brown sand — sandy loam — silty clay.

Forests

Area

The forest area of 70,000 square miles or 44,800,000 acres (17,920,000 ,hectares) represents 83 percent of the land area of British Guiana.

Ownership

Forests are both state owned and privately owned and are divided as follows:

Exploitable		
State		
Permanent	13,000	sq. mi.
Other	500	sq. mi.
Private	500	sq. mi.
Total	14,000	sq. mi.
Potentially Exploitable		
State		
Permanent	16,296	sq. mi.
Other	23,704	sq. mi.
Total	40,000	sq. mi.
Other Forest Lands	16,000	sq. mi.

Lands declared Crown Forests in 1953 may be divided as follows:

Exploitable		
Permanent	13,000	sq. mi.
Other	500	sq. mi.
PotentiallyExploitable	16,296	sq. mi
Total	29,796	sq. mi.

Utilization

At present much research is being done in the line of utilization, both for use on land and in the water. Information is available for only a small portion of the thousand odd species; more is being learned, however, about secondary species for housebuilding and furniture.

Some of the principal species and their products are:

Greenheart (*Ocotea rodiaei)* - Marine work and heavy construction.

Crabwood *(Carapa guianensis)* - Furniture and general construction.

Black Kakaralli *(Eschweilera spp.)* - Piling

Purpleheart *(Peltogyne densiflora)* House framing, bridging and turnery.

Mora *(Mora excelsa* - Railway sleepers and boat building, especially ribs.

Wallaba (*Eperua falcata)* - Transmission poles, vat staves, paling, charcoal and firewood.

Yellow Silverballi *(Aniba ovalifolia)* - Furniture and interior construction.

Mangrove (*Rhizophora mangle)* - Tanning.

Balata latex is produced and exported for cable insulation.

Forest Programme

Policy and Legislation

The basic forest policy of the country may be defined as follows:

1. The development of the forest resources of the Colony as part of an integrated land-use policy for the conservation and development of all natural resources.

2. The management of the forests on the basis of sustained yield i.e. the forests must be systematically managed as a renewable crop and not "mined" as a mineral.
3. Increase of production from the forests, subject to 2 above, with view to
   a. Filling the Colony's domestic requirements of forest products.
   b. Development of secondary processing industries within the Colony.
   c. Obtaining maximum export of forest products.
4. Assurance of a reasonable return to the community on the exploitation of the forest crop.
5. Development of markets for species now considered unmerchantable and the encouragement of "integrated" as opposed to "selective" logging.
6. Provision of access facilities to forest areas.

The most important legislation at this time concerns No. 5 above, the introduction of secondary and unknown species to the local and foreign market and the encouragement of integrated logging. This will prevent "creaming" of the forest and exhausting the stock of the presently known valuable species, Greenheart and Crabwood, on which the British timber trade was based.

In spite of the fact that local timber sales suffered a noticeable slump in the middle of 1953, it was encouraging to see the greater interest shown locally in about 20 kinds of other timbers during that year. It is felt that until a market for 30 to 40 species of timber is firmly established, forestry in the accepted meaning of the term, cannot commence.

Forest Organization

The Forest Department is divided into four different division — administration, utilization, silviculture, and patrol, all under a Conservator of Forests.

Personnel - There is a total of 113 persons employed in all divisions. The total consists of:

1 Conservator of Forests
1 Deputy Conservator
7 Assistant Conservators (University graduates)
5 Forest Inspectors
2 Technical Assistants (1 in silviculture, 1 in utilization)
9 Forest Rangers
14 Foresters
33 Forest Guards
28 Marine Staff (1 Foreman Mechanic, 1 Captain, 4 Engineers, and 22 boathands)
13 Clerical (under an Administrative Assistant)

Programme Aims

All Divisional forest officers or officers in charge of a forest district are preparing statements indicating the various categories of Crown Forest within their Division as being:

1. Forest suitable for sustained yield management.
2. Forest areas which will be cleared eventually for agricultural development.
3. Non-forested areas.

From this information divisional management plans will take shape. The first category is exploited by the large scale operators under long term leases (maximum 25 years) and systematic block working is enforced. No agricultural rights will be encouraged in these areas.

The secondary category lands will be exploited by small scale operators for timber, fuelwood, etc. with no control over size or species of timber, granting permission only to cut a specified amount of trees. Agricultural

expansion in these areas will be encouraged.

Third category lands are either already under agriculture or grazing or will be included in the land settlement schemes being implemented. Such lands were included within the Crown Forests by virtue of the natural boundaries which were selected.

These divisional plans, which still require more detailed research before final acceptance, are serving as very useful guides. In the meantime a management plan is prepared to provide for among other things, interim policy for the sustained yield management of some 14,000 square miles of mixed hardwood forest. (Berbice, Demerara ,Essequibo. Cuyni) and some 5,000 square miles of softwood forest (Northwest District) until working plans for the Permanent Forest Areas can be drawn up.

Training of staff to do this work is also a part of the programme. Besides local training, advantage is taken of the opportunities offered by foreign organizations to equip the officers with such knowledge as will be necessary to cope with the extensive work ahead.

Outlook for the Future

The outlook for future development seems hopeful because of several advantageous factors. A few of these favourable items are:

1. Eighty-three percent of the land is forested, about half of which is classified as potentially exploitable. This is essentially undisturbed virgin forest that is still to be worked while regeneration is in progress in the areas now being worked.
2. There is a complete meshwork of rivers and creeks that help tremendously to minimize the hazardous and costly land transportation experienced in other countries.
3. There is no extreme erosion hazard. The comparatively easy transportation of logs by way of the favorable meshwork of rivers and creeks eliminates much land transportation which is known to be a factor in encouraging severe erosion.
4. Fire is no problem. This is very fortunate and due, perhaps .to the many rivers and creeks, high rainfall, low-lying and often swampy lands - all favorable conditions for high humidity.

In addition to the above advantages, interest in the use of 30 odd species is being built up. This has brought about an incentive to cut these extra species whereas previously only four were cut.

The Forest Department lately acquired its own Central Manufacturing Plant erected with the view to popularising unused species by marketing them well manufactured and properly seasoned. At present there is a large building programme in the Colony. This permits the introduction of more new species to general use through proper processing in the Department Plant of rough lumber purchased from the sawmills. Additional knowledge is being gained concerning the potentialities of the forests; production will rise considerably with increased interest and markets for new species. Creaming of the forests for a few major species will cease and more species will be cut. As a result conservation will not constitute such a serious problem.

Major Forest Problems

Reforestation

Reforestation is still in an experimental stage; all operations are aimed to encourage natural regeneration in selectively exploited forests. No extensive afforestation has been carried out; mainly stand improvement.

One of the main problems along this line, is to reforest large areas of white sand that have been completely clear-cut for charcoal

and firewood. The soil is loose and very permeable. Several species including *Pinus caribaea*, are being tested for their adaptability to such soils.

No attempt has as yet been made at extensive nursery work. *Pinus caribaea* is being produced on an experimental scale for the adaptability test plantings on white sands. Erosion control is not now a problem in areas being selectively exploited.

Management

The problem in management is the shortage of an adequate staff in comparison with the extensive harvesting and production. At present all that is possible is to restrict cutting to a particular girth limit according to species, with the idea of a continual crop as the smaller trees attain the prescribed cutting size. This cannot be successful in all cases even with as rigid supervision as possible. However, it is all that can be done until a larger staff is acquired.

Silvicultural Systems and Treatments

The present silvicultural system in use is "Selective Felling". Some "Improvement Felling" has been carried out in the Greenheart forest as an experiment. The present objective, however, is "integrated" rather than "selective" logging.

Utilization

This has been partially dealt with previously. The problem is to encourage interest in the use of other species. For many years, the people have used and found a few species very satisfactory and have grown to acquire faith in them. The main problem is to prove to the public that there are other species that are just as good or even better for their individual uses.

The population buys only the few known species; the sawmiller purchases the logs only of those species that he can sell as lumber; the woodcutter fells and transports only the logs that the sawmiller will purchase. The result - the forest is creamed of only the few known species. This is most undesirable To prevent this chain of events an attempt is being made to compel woodcutters to remove all timber considered to be merchantable and to purchase all lumber produced by the sawmills subjected to Department grading rules. The Department will process and season such lumber and sell to the public with instructions for use of the various materials.

Research

A series of tests on the effects of preservatives on various local species is being carried out. Treated panels are left exposed to the weather to determine their durability as compared with untreated panels under the same tests. Other panels are sumerged in locations of salt water, fresh water, and brackish water to test their resistance to marine borer attacks.

Seeds and bark of several species have been sent to foreign laboratories for chemical analysis.

A comparative study is being made of the various regeneration experiments, both natural and artificial, but it is too early to draw any conclusions. Additional research is needed in all phases of work.

Miscellaneous Problems

There are no immediate problems as regards watershed management, erosion, grazing, wildlife, or recreation.

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MEXICO
CUBA
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STA. LUCIA
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VOLUME 18 NOS. 3 AND 4 JULY - DECEMBER, 1957

Caribbean Forester

El "Caribbean Forester", revista que el Servicio Forestal del Departamento de Agricultura de los Estados Unidos comenzó a publicar en julio de 1938 se distribuye semestralmente sin costo alguno y está dedicada a encauzar la mejor ordenación de los recursos forestales de la región del Caribe. Su propósito es estrechar las relaciones que existen entre los científicos interesados en la Ciencia Forestal y ciencias afines encarándoles con los problemas confrontados, las políticas forestales vigentes y el trabajo que se viene haciendo para lograr ese objetivo técnico

Se solicita aportaciones de no más de 20 páginas mecanografiadas. Deben ser sometidas en el lenguaje vernáculo del autor, con el título o posición que este ocupa. Es imprescindible incluir un resumen conciso del estudio efectuado. Los artículos deben ser dirigidos al Líder, Centro de Investigaciones Forestales Tropicales, Río Piedras, Puerto Rico.

Las opiniones expresadas por los autores de los artículos que aparecen en esta revista no coinciden necesariamente con las del Servicio Forestal. Se permite la reproducción de los artículos siempre que se indique su procedencia.

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The "Caribbean Forester", published since July 1938 by the Forest Service, U. S. Department of Agriculture, is a free semiannual journal devoted to the encouragement of improved management of the forest resources of the Caribbean region by keeping students of forestry and allied sciences in touch with the specific problems faced, the policies in effect, and the work being done toward this end throughout the region.

Contributions of not more than 20 typewritten pages in length are solicited. They should be submitted in the author's native tongue, and should include the author's title or position and a short summary. Papers should be sent to the Leader, Tropical Forest Research Center, Río Piedras, Puerto Rico.

Opinions expressed in this journal are not necessarily those of the Forest Service. Any article published may be reproduced provided that reference is made to the original source.

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Le "Caribbean Forester", qui a été publié depuis Juliet 1938 par le Service Forestier du Département de l'Agriculture des Etats-Unis, est une revue semestriele gratuite, dediée a encourager l'aménagement rationnel des forêts de la region caraibe. Son but est d'entretenir des relations scientifiques entre ceux qui s'interéssent aux Sciences Forestières, ses problemès et ses méthodes les plus récentes, ainsi qu'aux travaux effectués pour réaliser cet objectif d'amelioration technique.

On accept voluntiers des contribution ne dépassant pas 20 pages dactilographiées. Elles doivent ètre écrites dans la langue maternelle de l'auteur qui voudra bien préciser son titre ou sa position professionnelle et en les accompagnant d'un résumé de l'étude. Les articles doivent ètre addressés au Leader, Tropical Forest Research Center, Río Piedras, Puerto Rico.

La revue laisse aux auteurs la responsibilité de leurs articles. La reproduction est permise si l'on présice l'origine.

*The printing of this publication has been approved by the Director of the Bureau of the Budget (June 26, 1958)

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Las Plantaciones de Eucalipto de la Compañía Minas de Matahambre, S.A. en la Provincia de Pinar del Río, Cuba [1/]

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La Compañía Minera "Minas de Matahambre, S. A." que opera en la parte norte de la Provincia de Pinar del Río, Cuba, inició las labores de reforestación con eucalipto durante el año 1949, con la finalidad de producir la madera necesaria para los trabajos de la mina. El autor fué designado Jefe de las labores de reforestación, y en julio de ese año se plantaron los primeros árboles. Al principio hubo las naturales dificultades debido a no contar con la experiencia de otros trabajos similares, pues esta es la plantación de eucalipto más grande de Cuba con un fin comercial definido, y la única dirigida por un técnico forestal.

Esta iniciativa de la Empresa se debe a la capacidad emprendedora de su Presidente, el Dr. Ernesto Romagosa, y a la colaboración entusiasta de su Administrador General, que han comprendido la grave situación que se presenta por el agotamiento de los bosques de coníferas de casi todas las regiones de Cuba.

Entre las industrias que utilizan madera en Cuba, "Minas de Matahambre, S. A." ha sido la única capaz de realizar un plan serio de repoblación forestal, colaborando así con la política de reforestación del país.

SITUACION GEOGRAFICA

Las plantaciones se han plantado en dos puntos separados 20 kms. entre sí, pero la diferencia de situación no es apreciable. Las plantaciones aproximadamente están situadas a 22º 40' latitud norte y 84º 10' longitud oeste Greenwich.

DATOS ECOLOGICOS

Las plantaciones de eucalipto se iniciaron en la finca de "La Manaja", municipio de Mantua, Provincia de Pinar del Río, Cuba en la fecha ya mencionada, donde se continuó plantando hasta 1953. En esta fecha se suspendió la plantación en este lugar y se continuaron los trabajos de reforestación en otra finca denominada "Cabezas de Horacio", situada a unos 20 kms. al suroeste de la primera, y de condiciones ecológicas distintas en cuanto a suelo y vegetación se refiere.

"La Manaja" es un valle de cierta extensión, de suelo en su mayor parte de aluvión, con pH de 6 y una elevación de 50 metros sobre el nivel del mar. Este valle es atravesado por un río y varios arroyos o cañadas que sostienen el agua todo el año.

La vegetación natural, cuando se iniciaron las labores de reforestación con el eucalipto, estaba constituída por especies planifolias representadas por árboles de madera de escaso valor en la zona, algunos arbustos y abundancia de bejucos, o sea, plantas trepadoras.

La finca "Cabezas de Horacio", donde se continuó la plantación en 1953, está situada en una sabana derivada de serpentina, de suelo laterítico, color rojo con algo de arcilla, profundo, de pH 5.5 y muy susceptible a la erosión. El subsuelo es bastante permeable, constituído por suelo menos arcilloso

1/ Trabajo presentado por el representante de la Compañía Minera "Minas de Matahambre, S. A." a la Conferencia Mundial del Eucalipto celebrada en Roma del 17 al 30 de octubre de 1956.

y rocas de cuarzo algo redondeadas. Esta zona comprende un altiplano próximo a la costa con una elevación de 150 ms. sobre el nivel del mar. Véase Fig. 1.

Fig. 1.—Aspecto de las tierras rojas de Cabezas de Horacio mostrando un lote de Eucalyptus saligna ocho meses después de plantado.

La vegetación natural o espontánea está constituída por gramíneas de poco valor para el ganado y arbustos achaparrados también sin valor alguno. Las condiciones ecológicas de la zona que se describe corresponden al bosque tropical seco, según la clasificación del Dr. Leslie R. Holdridge (1949), teniendo la temperatura media anual de 25°C., y una precipitación media anual de 1,600 mms. En Cuba hay dos estaciones: la "Estación de las Lluvias" de mayo a octubre y la "Estación Seca" de noviembre a abril.

PRODUCCION DE LAS PLANTAS

Al principio, parte de la semilla empleada en esta plantación se obtuvo de una casa vendedora de semillas de varias especies de eucalipto en los Estados Unidos de América, la que según informes las importa del Brasil, pero en la actualidad la semilla se obtiene del Vivero Forestal de Pinar del Río, perteneciente a la Dirección de Montes del Ministerio de Agricultura, Cuba, donde existen hermosos ejemplares de *Eucalyptus saligna* Sm., y otras especies que fueron plantadas por el ingeniero Alberto J. Fors y Reyes, actual Director de Montes, a quien se debe la propagación de esta importante especie forestal en Cuba.

El mejor resultado se ha obtenido preparando los semilleros con marcos de madera sobre el suelo (canteros construídos con tablas) de 8 a 10 pulgadas de alto, 1 metro de ancho y 15 metros de longitud, llenando estos marcos con tierra silícea pobre en materia orgánica. La semilla se distribuye sobre el cantero a razón de 40 gramos por metro cuadrado, y seguidamente se aplica un kilogramo de abono químico o comercial fórmula (3-8-2). Se aplican riegos con regadera mañana y tarde, para mantener húmedo el suelo. Hemos observado que para obtener una germinación uniforme es necesario proporcionarle sombra durante 6 u 8 días, la que se suprime después gradualmente.

La germinación tiene lugar en un promedio de 8 días, y a los 30 ó 35 días de sembrada la semilla, la plantita está en condiciones de ser pasada a las macetas. Un semillero como el arriba descrito da un rendimiento de más de 2,000 plantas sanas por metro cua-

drado, sin contar que siempre se desecha más de una tercera parte del total de las plantas porque se seleccionan las plantas de mejor calidad para trasplantar a las macetas.

En Cuba la época más apropiada para el semillero de eucalipto es la comprendida entre los meses de enero y marzo.

PREPARACION DE MACETAS Y SISTEMAS DE SIEMBRA

En Cuba la plantación de Eucalipto a raíz desnuda no tiene éxito, especialmente cuando se trata de grandes plantaciones, por lo que hay que usar el sistema de macetas. Véase Fig. = 2.

Durante los primeros años se usó un tamaño algo mayor para la maceta, usando el papel asfaltado pero con el uso del nuevo papel, el tamaño se redujo a 8 cms. de diámetro y 15 cms. de alto (volumen de 764 cms. cúbicos) lo que permite transportar mayor número de plantas por unidad de superficie. La reducción de volumen no afecta en nada al desarrollo de las plantitas, y es posible que pueda reducirse aún más sin afectar el desarrollo. Los cilindros o macetas se hacen cortando el papel en piezas rectangulares de 6 x 11 pulgadas, y uniendo los extremos con tres presillas. El fondo de la maceta se le pone simplemente con tierra normal algo húmeda,

Fig. 2.—Macetas colocadas en el vivero para sembrarle posturas de Eucalyptus. Al fondo se ve el semillero o almácigo.

Hasta 1953 se usó un papel asfaltado de techar para la preparación de las macetas; en 1954 se probó un papel de producción americana llamado Febreen 220, el cual dió magníficos resultados, pues además de ser más barato tiene la ventaja de que no hay que quitar el papel en el momento de plantar, como sucede con el papel de techar. De este modo se logró un aumento notable en el rendimiento de cada obrero, en la labor de plantar o sembrar. Mientras que con el papel de techar un obrero planta al día 400 árboles, en terreno preparado, usando macetas de papel Febreen 220 — se pasa de 1,000 como promedio al día.

que se comprime con el fondo de una botella pequeña. Las plantitas del semillero se extraen cuando tienen 6 hojitas (6 a 8 cms. de alto) para trasplantar a las macetas. La tiera de las macetas se remoja y sin hacer previamente hoyos, se mete la raíz de la planta con el dedo índice mojando de nuevo para que la tierra quede unida; este sistema de siembra se reconoce en Cuba con el nombre de "SIEMBRA AL DEDO" y es muy usado en el cultivo del tabaco y lo estamos aplicando en el eucalipto con magníficos resultados, pues la reposición de fallas a veces no llega a un 3 por ciento. Durante los primeros días

se le proporciona sombra para evitar que el sol marchite demasiado las plantitas.

ACONDICIONAMIENTO DEL TERRENO Y PLANTACION

En la plantación inicial de "La Manaja" se preparó el terreno siguiendo el método de "CORTE A MATA-RASA" de toda la vegetación, seguido de quema total para dejar libre el suelo. Luego se cavaron los hoyos de 25 cms. de diámetro y 40 cms. de profundidad. La distancia entre las plantas fué variable de 8 y de 9 pies.

En esta plantación se obtuvo éxito, pues los eucaliptos alcanzaron gran desarrollo, pero el costo de las atenciones de limpia fué algo elevado, debido al rápido crecimiento de renuevos de tocones y plantas trepadoras, por lo que fué necesario dar hasta cuatro limpias por año a una misma plantación. A fin de reducir el costo de las atenciones culturales se decidió plantar en otro suelo desprovisto de esa vegetación leñosa que hiciera posible la roturación por medios mecánicos (tractor y arado). En 1953 se hizo una prueba de 2 años con 36 hectáreas en las tierras rojas que se han mencionado, utilizando un equipo contratado. Se tuvo éxito económicamente y en el desarrollo de los árboles, pues en esta nueva plantación no fué necesario realizar labores de limpia. En 1954 la empresa adquirió un equipo, se hicieron las construcciones necesarias y se trasladó definitivamente la plantación para ese lugar.

El suelo se rotura con arado a 25 cms. de profundidad, y seguidamente se le da dos labores de grada y picadora; los hoyos para la siembra han sido sustituídos por surcos siguiendo las curvas de nivel. Estas se abren con un tractor equipado de arado de doble vertedera, siguiendo dichas curvas en el terreno, quedando así listo para la siembra. Con la práctica de surcos a curvas de nivel se ha logrado reducir notablemente la erosión.

Las plantas en macetas se transportan al campo con el tractor equipado de trailer o carro de arrastre, y se sitúan en lugares de donde son distribuídas en los surcos por los obreros (regadores). Otros obreros (sembradores) se encargan de sembrar o aterrar las macetas en los surcos. Para marcar el lugar y la separación de cada planta, cada obrero está provisto de una vara medidora. En este lugar la distancia de plantación fué de 6 ps. x 7 ps., 7 x 7 y 8 x 8 pies; esta última ha dado los mejores resultados.

EPOCA DE PLANTACION

En Cuba la época más apropiada para plantar eucalipto en el campo está comprendida en los meses de mayo a julio, o sea, el comienzo de las lluvias.

Hasta la fecha se han plantado 294,627 eucaliptos de varias especies, mayormente *E. saligna*, en las tierras de "La Manaja" y 373,717 *E. saligna* en las tierras rojas de "Cabezas de Horacio", teniendo un total de 668,344 eucaliptos plantados en las dos fincas.

ESPECIES QUE SE HAN PROBADO

Se han ensayado las especies siguientes, clasificadas según la bondad que demostraron en las plantaciones:

E. saligna Sm.
E. citriodora Hook
E. tereticornis
E. paniculata Smith
E. maculata Hook
E. rostrata Schlecht. (no dió resultado)
E. robusta Smith
E. microcorys F.V.M. (no dió resultado)

De todas las especies *E. saligna* es la que se está plantando por ser la más prometedora y la que mejor se adaptó por su rápido crecimiento, forma erecta del fuste, magnífica poda natural, resistencia al trasplante y facilidad para manipularla en el vivero.

APLICACION DE FERTILIZANTES

La experiencia ha demostrado que para el establecimiento de plantaciones de eucalipto es muy conveniente estimular el desarrollo inicial con una pequeña cantidad de abono,

especialmente cuando se trata de suelos de sabana, que son pobres en elementos nutrientes. Dichos suelos abundan en Cuba pudiendo ser dedicados al cultivo del eucalipto. En el semillero se está usando la fórmula (3-8-2), a razón de un kilógramo por metro de cantero y para las plantas en macetas se usa la fórmula (5-7-8) a razón de 5 gramos por planta. En la plantación se aplica 2 onzas por planta, también de la fórmula (5-7-8), de una sola vez, una semana después de la plantación.

Se ha comprobado que aplicando fertilizantes se reduce a la mitad el tiempo necesario para hacer una plantación; por ejemplo, un semillero sin abono, por buena que sea la tierra, no produce posturas antes de los 50 días de sembrada la semilla, y con abono produce a los 30 días.

Así, siguiendo el sistema de aplicar fertilizantes, hemos efectuado una plantación de 52,717 eucaliptos en 94 días, desde la siembra de la semilla (febrero 15), hasta plantar el último arbolito (mayo 18), todo lo cual se traduce en economía de tiempo y trabajo.

PLAGAS Y ENFERMEDADES

El eucalipto en Cuba tiene pocos enemigos, pues el mayor es la bibijagua *(Attas insulares)* que es una hormiga cortadora de hojas que ocasiona mucho daño en el vivero y en la plantación. Este insecto se ha controlado erradicándolo con bromuro de metilo. Los demás insectos que atacan al eucalipto en Cuba carecen de importancia económica.

El *damping-off* en Cuba es la enfermedad más importante que ataca al eucalipto. Esta enfermedad hace su aparición en los semilleros o almácigos y la mayor parte de las veces causa graves daños. Su ataque es más frecuente en los meses de marzo a mayo que de enero a marzo, y también es más frecuente en suelos ricos que en suelos pobres en materia orgánica. La experiencia ha demostrado que empleando suelos silíceos, pobres en materia orgánica, renovándolos cada año y sembrando la semilla antes de marzo se reduce notablemente la posibilidad de enfermedades fungosas.

Se han probado algunos fungicidas comerciales sin resultado. Ultimamente se está ensayando una fórmula a base de una sal de potasa, cuyos resultados son prometedores.

Esta investigación se ha hecho en parcelas de *Eucalyptus saligna* ya que es la especie que ha dado mejor resultado y la única que se está plantando. A continuación se expone un cuadro que indica el proceso de crecimiento de dichas parcelas desde 1 hasta 5 años.

DIAMETRO MEDIO NORMAL (1.30 MS. DESDE EL SUELO), MEDIDO EN PULGADAS EN ARBOLES DESDE 1 HASTA 5 AÑOS EN LAS PARCELAS DE ESTUDIO

	1 año	2 años	3 años	4 años	5 años
Diámetro medio normal	1.883	2.941	4.502	6.070	6.913
Incremento anual en diámetros	——	1.058	1.561	1.568	0.837
Incremento medio anual en diámetro	——	1.470	1.336	1.517	,1.382

A los 5 años la altura media de las parcelas es de 27 metros.

Los árboles mayores tienen hasta 14 pulgadas de diámetro normal (1.30 metros desde el suelo) en 5 años.

El espaciamiento de estas parcelas es de 9 x 9 pies plantadas en suelo fértil de "La Manaja". Puede apreciarse en las cifras anteriores que el crecimiento anual va decreciendo del cuarto al quinto año, lo que parece explicarse por la competencia entre los árboles. Por esta razón se está pensando en efectuar próximamente una corta por entresaca, a fin de utilizar la madera para los trabajos de la mina.

De acuerdo con las medidas efectuadas en la plantación de las tierras rojas de "Cabezas de Horacio", parece que el crecimiento va a resultar tan bueno como en las tierras fértiles de "La Manaja", pues el crecimiento medio en planta de un año es de 1.83 pulgadas en una plantación cuyo espaciamiento es de 7 x 7 pies. (Véase Fig. = 3).

Fig. 3.—Arbol de Eucalyptus saligna que produjo 6 bocaminas o un fuste aprovechable de 56 pies a los 5 años de plantado.

RENDIMIENTO DE ARBOLES CORTADOS Y PRUEBAS DE LA MADERA

En diciembre de 1954 se cortaron 10 árboles *(Eucalyptus saligna)* los cuales habían sido plantados en julio de 1949, cuyas dimensiones y rendimientos en piezas para la mina (bocamina) fué el siguiente:

Diámetro en la base Pulgadas	Piezas por Arbol 8" x 8'	Velas	Fuste Aprovechable Pies	Diámetro Superior Pulgadas
15	2	4	56	6.5
13	2	2	36	7.5
12	2	1	26	6
13.5	2	2	36	6.5
13.5	2	1	26	6.5
12.5	2	2	36	6
13	2	1	26	6.5
11.5	1	2	28	6.5
13	2	2	36	7
12	1	1	18	6.5
Total	18	18	= 36	

Las piezas denominadas 8" x 8' tienen una longitud de 8 pies y más de 8 pulgadas de diámetro en el extremo delgado. Las velas tienen 10 pies de longitud y 6 pulgadas o más de diámetro en el extremo más delgado. Estas piezas se trataron al vacío y en enero de 1955 se colocaron en la mina para comparar su durabilidad y resistencia con piezas del pino *(Pinus tropicalis)*. A los 10 meses las piezas de eucalipto estaban en buenas condiciones, sólo que algunas se quebra-

ron por el centro, mientras que el pino, también doblado por la presión del terreno no mostraba quebradura, lo que parece indicar que el pino tiene más flexibilidad que el eucalipto. Según la información estas piezas se colocaron en un lugar de máxima presión donde todas las maderas duran muy poco tiempo.

En febrero de 1955 se cortaron 55 postes de 28 pies de longitud y más de 6 pulgadas de diámetro en el extremo más delgado, para tendido eléctrico, los que fueron tratados también al vacío y donados por la "Empresa Minas de Matahambre, S. A." a un colegio de la provincia de La Habana, Cuba. donde están prestando servicio sin dificultad.

Además, el eucalipto, cuyas aplicaciones estamos empezando a conocer en Cuba, no sólo puede ser utilizado en trabajos de minería, sino que ya se utiliza en la construcción de casas de curar o secar tabaco en toda la provincia de Pinar del Río, a cuyo efecto se están fomentando algunas plantaciones por empresarios particulares.

CONSIDERACIONES ECONOMICAS

El costo de plantar un árbol está influenciado por diversos factores tales como: ecología del lugar, sistema selvícola empleado, renta del suelo, el costo de materiales, mano de obra y atención técnica. Desde luego que no es posible discutir cada uno de ellos separadamente, porque su influencia varía en cada lugar, por tanto vamos a discutir ligeramente los que han influído en la rebaja del "Costo de Plantación", factor que constituye un problema básico en todos los lugares.

En la primera plantación de la finca "La Manaja" (tierras cubiertas de vegetación) el costo por planta ha sido el siguiente:

Costo de plantación	$ 0.0920	dólar
Costo de material	0.0282	"
Costo de limpias (de 1950 a 1954)	0.0684	"
Costo Total por planta	$ 0.1886	"

En esta plantación, después del desmonte, la vegetación secundaria (renuevo de tocones y plantas trepadoras) es muy abundante, siendo por tanto muy costosas las atenciones culturales, como puede apreciarse en las cifras anteriores.

En la segunda plantación de las tierras rojas de la finca "Cabezas de Horacio", el costo ha sido en 1953 el siguiente por planta:

Costo de plantación	$ 0.0483	dólar
Costo de preparación de terreno	0.0170	"
Costo de materiales	0.0212	"
Costo Total por planta	$ 0.0870	"

Al comparar el costo de ambas plantaciones veremos que resulta una rebaja de $0.1016 dólar por planta en la plantación — de "Cabezas de Horacio". Los factores determinantes son los siguientes:

1. En "Cabezas de Horacio" se trabajó en suelo preparado con arado y desprovisto de malezas, puesto que fué posible mecanizar la roturación del mismo y el transporte de material de siembra del vivero al campo.
2. Se cambió el papel de techar usado anteriormente para las macetas por otro más económico y más fácil de manipular, aumentando el rendimiento promedio de cada obrero.
3. No es necesario inversiones en operaciones de limpias, pues la vegetación de este lugar está constituída por gramíneas que no estorban el libre desarrollo del eucalipto.

The Lumber Industry of the Lower Amazon Valley

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Despite an excellent river system, extensive forest resources, and many other factors which are basically favorable to the development of forest industries, very little development work has taken place in the lower Amazon Valley. The production of logs, lumber, crossties, and other forest products is small and the cost of production is high. Sawmilling is practically the only existing form of industrial processing. Heretofore, development has been retarded by the lack of capital as well as technical knowledge and skill.

Recently certain steps have been taken with a view to developing the forest resources of this region on an extensive scale. An American company is installing a modern veneer and plywood plant and sawmill at Portel, situated in the upper estuary region, and has acquired extensive bodies of timberland on which they plan to initiate modern logging methods. A mixed company of French and Brazilian capital is being organized to install a pulp and paper mill in the estuary region which will utilize the broadleaved timbers of this region. Other forest enterprises are being studied by American, West German, and Japanese capitalists.

The area and forests which the writer considers most promising for development includes the islands of the Amazon estuary as well as the mainland from the Rio Guama westward to the valley of the Rio Xingú. The best map of this region is the Aeronautical Chart, Ilha de Marajó 946 printed by the Department of Commerce, Washington, D.C.

At Belém the average annual rainfall is 97 inches while the temperature varies from a mean maximum of 87°F. to a mean minimum of 72°F., with a mean annual temperature of 78°F. Although the climate of this region is tropical, it is very healthful. Malaria and hookworm are the principal diseases among the native population but both can be very easily controlled by proper sanitary measures. By use of the modern drugs and insecticides, these diseases can be eliminated from any tropical region at a very moderate cost as American and Brazilian doctors and sanitary engineers of the SESP have demonstrated.

TRANSPORTATION FACILITIES

Vessels drawing up to 24 feet of water can load at low tide at most of the island estuary ports while some of the rivers are navigable for a distance of 25 miles from the estuary for vessels of 16-foot draught. All rivers are navigable for launches and tugs of 9-foot draught almost to the first waterfalls or rapids. The difference between high and low tide varies from about 5 feet in the estuary to about 6 inches below the first falls or rapids. Therefore, log rafts can only be floated downstream at ebb tide. Marine-borers are not a problem as most of the water in the estuary is fresh.

The greater part of the land in the islands of the Amazon estuary is swampy or periodically inundated, although there is some high land on some of the larger islands. There are also certain areas of inundated land on the mainland where the rivers flow into the estuary. The land between the rivers and their tributaries is almost flat although it is well drained. These flat benches are situated 5 to 300 feet above the rivers and their tributaries.

The islands of the Amazon estuary are Quarternary deposits of alluvial sediments, while the underlaying geological formation on the mainland consists of unconsolidated sediments which are chiefly clays. No rock is exposed on the mainland below the first wa-

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terfalls where outcrops of sandstone or crystalline rocks do occur. The first waterfalls or rapids are situated 75 to 150 miles upstream from the Amazon estuary. The soils of the upland forests vary from heavy plastic clays to light sandy loams. As far as topography and bottom are concerned, track-type tractors can operate the entire year and light trucks from July 1 to December 1.

FOREST TYPES AND KINDS OF TIMBER

The evergreen tropical rain forests of the lower Amazon Valley can be divided into three broad types: (1) the "igapo" (swamp) forests of the islands of the estuary as well as limited areas on the mainland; (2) the "varzea" (lowland) forests of the flood plain of the lower Amazon Valley and the islands of the Amazon estuary, which are periodically inundated; and (3) the upland forests or "matas da terra firme" which are situated on high well-drained land. Each type possesses its characteristic species, although certain species, such as the Hevea rubber tree, are encountered in all three forest types. These forests, like all tropical rain forests, are characterized by the large number of species encountered on limited areas. However, certain species, e.g. andiroba *(Carapa guianensis Aubl.)* and ipeuba *(Eperua bijuja Benth)* in the lowland forests, sucupira do igapo *(Diplotropis martiusi Benth)* in the swamp forests, and another sucupira da mata *(Bowdichia nitida* Spruce) in the upland forests may comprise as much as 80 percent of the stand on limited areas. On an area of about 150,000 acres recently examined by the writer in the upper estuary region, 140 arborescent species were encountered and identified besides about 25 species which neither the writer nor the native woodsmen accompanying him were able to identify. Of those identified, 81 species were encountered in the upland forests, 31 species in the lowland forests, and 28 species in the swamp forests.

With notably few exceptions, the trees in all three types are of good timber form possessing straight clear cylindrical boles with moderate taper above the first 16-foot log. In general, the swamp or lowland species are buttressed or have swollen bases and have more taper than the upland species. Macaranduba *(Manilkara huberi* Ducke). which is an upland species is also buttressed to a height of 4 to 5 feet. Unlike most hardwoods of the temperate zone, the bark of tropical broadleaved trees is remarkably thin, varying from 1/4 to 1-1/4 inch in thickness. The trees in the upland and lowland forests are larger and taller than those in the swamp forests. Mature timber in the former is commonly 100 to 150 feet tall yielding 3 to 5 16-foot logs with a diameter range of 16 to 72 inches, averaging 18 to 28 inches.

As in most tropical forests, the timber in the lower Amazon Valley is very unevenly distributed. The number of trees of merchantable size in the swamp forests is frequently very low. On the other hand, in the upland and lowland forests the number of trees of merchantable size, as well as the density of the stands, is remarkably uniform as to species and volume per acre over limited areas. Therefore, it is exceedingly difficult to make an accurate evaluation of the stands of timber per acre by the sample plot method of cruising where the areas of the different types are unknown. The strip survey method of cruising on parallel lines perpendicular to the rivers or their tributaries is indicated. A strip 20 meters in width at kilometer intervals will give a 2 percent cruise of the area. Sample plots selected by the writer in the swamp forests tallied from 1,500 to 4,500 board feet (Doyle-Scribner) per acre while sample plots in the upland and lowland forests tallied from 4,500 to 27,000 bd. ft. (Doyle-Scribner) per acre. No trees were tallied which did not contain one 16-foot log inches or more in diameter. By tallying all timber of pulpwood size (6 inches or more in diameter) blocks of timberland several thousand acres in area could be selected in the lowland and upland forests which would average 15,000 board feet or 30 cords per acre.

AMAZON TIMBERS OF VARIED UTILITY

The wood of the 140 species encountered by the writer varied in weight from 11 to 83 lbs. per cubic foot in an air-dry condition. As the weight of a wood is a fair indication of its strength, these woods have a very wide range in physical and mechanical properties and therefore have a wide range in utility. Some species, such as Marupá *(Simaruba amara* Aubl.), morototo *Didymopanax morototoni* Aubl.) (D. and P.), the quarubas *(Vochysia* sp. and *Qualea* sp.), and parapara *(Jacaranda copaia* (Aubl.) D. Don), are lightweight perishable woods suitable only for ceiling, boxes, concrete forms, corestock and interior construction. Others, such as jutaiacu *(Hymenaea courbaril* L.) Cumarú *(Coumarouna odorata* Aubl.), pracuuba *(Mora paraensis* Ducke) are exceedingly hard, heavy, strong, and durable and are used for all purposes requiring strength, toughness, resilience, and resistance to wear, insects, and decay. Some woods, such as itaúba preta *(Mezilaurus itauba* (Meissn.) Taub.) mata-matá *(Eschweilera odorata* (poepp.) Miers), parinari *(Parinari rodolphi* and anuera) *(Licania macrophylla* Benth.), resist the attacks of marine-borers and are therefore used for keels and bottom planking in boatbuilding as well as marine piling, sheet piling, and dock timbers. Piquia *(Caryocar villosum* (Aubl.) Pers.) is exceedingly difficult to split on account of its interlocking grain and is greatly esteemed for knees, ribs, rudders, hatch covers, and decking in boat-building. Some species, such as acapú *(Vouacapoua americana* Aubl.), sucupira *(Bowdichia* sp. and *Diplotropis* sp.) and pau amarelo *(Euxylophora paraensis* Hub), are highly suitable for plain and parquet flooring, while macacauba *(Platymiscium ulei* Harms), freijó *(Cordia goeldiana* Huber), pau roxo *(Peltogyne Le Cointei* Duke), ipeuba, and muirapiranga *(Brosimum paraense* Hub), are high class cabinet woods and are highly suitable for face veneers and decorative plywood. Andiroba, louro vermelho *(Ocotea rubra* Mez), and jacareuba *(Calophyllum brasiliense* Camb.), are promising substitutes for mahogany. Sucupira, macaranduba, pracuuba, margoncalo *(Hieronyma alchorneoides Fr. Allem.)*, mata-matá preta, araracanga *(Aspidosperma desmanthum* Mull Arg.), sapucaia *(Lecythis paraensis* Hub), cumarú, and many other woods are highly suitable for crossties. The fragrant cedro vermelho *(Cedrela odorata* L.) is used for cigar boxes while pau roxo, carapanúba *(Aspidosperma nitidum)* Benth) pitica *(Swartzia platygyne)*, and some of the enviras *(Xylopia* sp. and *Dugetia* sp.) are used for tool handles.

AMAZONIAN TIMBERS POSSESS EXCEPTIONAL PROPERTIES

From 1947 to 1955 the School of Forestry of Yale University, in cooperation with the Office of Naval Research of the U. S. Navy Department, tested a number of Amazonian hardwoods along with other tropical American hardwoods to determine their mechanical, physical, seasoning, moisture absorption, machining, glueing, and steam-bending properties. The test revealed that these hardwoods shrink less from a green to an air-dry condition than hardwoods of the temperate zone and, consequently, they posses greater dimensional stability after seasoning. Even the extremely dense tropical woods show appreciably less shrinkage than is commonly displayed by American hardwoods only three-fourths as heavy. These woods tested in a green condition displayed a greater superiority in bending strength, stiffness, crushing strength, and a number of other properties over American woods of comparable density. However, this superiority is less evident after seasoning. The test also revealed that the air-dry strength of tropical woods in cleavage and tension across the grain is commonly less than in the green condition. The value of certain Amazonian hardwoods for exacting uses can be readily appreciated from these tests which revealed that cumarú is 150 percent harder, 70 percent stronger as a beam; and 75 percent stronger as a column than

American white oak, while macaranduba is 108 percent harder, 114 percent stronger as a beam, and 110 percent stronger as a column than white oak. The volumetric shrinkage of limorana *(Chlorophora tinctoria* (L.) Gaud.) was only 7.6 percent as compared to 9.8 percent for American black locust while the moisture absorption of louro vermelho was only 5.5 percent as compared to 8 percent for Burma teak indicating a very high dimensional stability for these woods.

PRIMITIVE LOGGING METHODS

In the Amazon estuary region sawmill operators rarely own standing timber and do not generally engage in combined logging and sawmill operations but purchase their logs from landowner, store-keeper, or small logging operators. Although logs of some of the lighter woods are occasionally rafted to the sawmills by native loggers, most of the sawmills transport their logs from the river landings or other assemblying points to their mills in lighters or barges conveyed by tugboats.

In this region all logs are measured in accord with the so-called Francon rule, which is the Hoppus quarter-girth system of measurement used in Burma, India, and some parts of Africa. The circumference is taken inside the bark in the middle of the log and divided by four. Tre result is squared and multiplied by the length in accordance with the following formula:

$$V = (C/4)^2 \times L$$

Approximately 7.25m³ of logs by this system of measurement will give 1,000 board feet by the Doyle-Scribner system of measurement. Approximately 1.8 m³ of logs by the Francon measure are required to yield 1 m³ of lumber or 424 board feet. Sawmills are now paying from Cr. $120,00 for andiroba to Cr. $700,00 for freijó per m³ Francon, for logs having a minimum circumference of 1.40 m and a minimum length of 4 m at the river landings or other assemblying points in the estuary region. Converting the above values into dollars worth Cr. $64.00 in the free market, sawlogs are therefore worth from US $13.60 for andiroba to US $56.64 for freijó per thounsand bd. ft. (Doyle-Scribner). Sawmill operators in the estuary state that it costs from Cr. $100,00 to Cr. $150,00 per m³ Francon or US $4.51 to US $6.80 per thousand bd. ft. (Doyle-Scribner) to transport logs by barges and tugs from the river landings to their sawmills situated on deep-water ports in the estuary.

The logging methods employed in this region are very primitive, in fact, timber is extracted in the same manner as it was 400 years ago by the Portuguese traders. Manual logging methods are employed exclusively. The trees are felled and cut into log lengths with an axe, after which the logs are rolled to the river banks by hand labor. Extensive roads or skidways are opened through the forests and stringers and rolls are used to facilitate the removal of logs to the river banks. Quite frequently only one or two species are logged at one time which increases the cost of logging. In general, timber situated only a few hundred meters from the banks of the rivers or tributary streams is logged by this primitive method. However, in some sections the more valuable species, such as cedro, pau amarelo, and freijó have been logged for a maximum distance of 6 kilometers (3.7 miles). It is hardly necessary to add that this system of logging is very laborious and expensive and cannot compete in cost with modern logging methods.

ANTIQUATED SAWMILL METHODS

The sawmills in the Amazon estuary region cannot be considered as modern either in equipment or methods. At present there are nine sawmills situated on the islands of the estuary and in Belém. The head saw in most of the mills is of the American circular type although some mills are equipped with a heavy gang saw (engenho) of European manufacture or design. A few possess antiquated band saws also of European manu-

facture or design. All are powered by steam but only one is equipped with the Dutch oven type of firebox and even this one does not burn sawdust or planing mill shavings. Many of the sawmills are underpowered which greatly reduces production. Edgers are rarely employed and the trimming is done with swinging cut-off saws. Most mills are equipped with table saws and planers. In most of the mills the machinery is not set up in proper sequence for economical operation. The lumber is transferred from one machine to another by hand labor. The use of such modern labor-saving devices as live rolls, transfer tables, lumber stackers, sawdust conveyors, or even lumber buggies and dead rolls is unknown. None of the mills possesses dry kilns and the lumber is milled green or only partially seasoned. Owing to the antiquated equipment and the obsolete methods employed, production is very low. The larger mills manufacture from 2,000 m^3 (848,000 bd. ft.) to 6,000 m^3 (2,544,000 bd. ft.) anually. The total lumber production of the State of Pará is about 30,000 m^3 (12,720,000 bd. ft.) annually.

TIMBERLANDS DIRT CHEAP

In this region standing timber has a stumpage value of 10 percent of the value of the logs delivered at the river landings. Stumpage can therefore be obtained at Cr. $12,00 for andiroba to Cr. $70,00 for freijó per m^3 Francon or US $1.36 for andiroba to US $5.66 for freijó per thousand bd. ft. (Doyle-Scribner). Timber removed from State land is supposed to pay an Imposto Patrimonial of 5 percent of the official value (pauta) of Cr. $20,00 to Cr. $600,00 per m^3 Francon for logs depending on the species.

Perhaps not over 30 percent of the land in the valleys of the rivers flowing into the estuary is privately owned, the balance being State land. However, considerable State land is occupied by temporary squatters, especially lands possessing rubber or Brazil nut trees. Privately owned lands, some possessing primitive improvements, can be purchased at Cr. $10,00 to Cr. $20,00 per hectare or from 6 to 12 cents (US) per acre. An additional 20 percent should be added for the State land transfer tax (8.25 percent), examination of titles, register of deed, etc.

State lands are now sold at the following prices: 1 to 1,000 hectares Cr. $1,10 per hectare; 1,001 to 2,000 hectares Cr. $1,20 per hectare; 2,001 to 3,000: Cr. $1,30 per hectare; 3,001 to 4,000 hectares Cr. $1,40 per hectare; over 4,000 hectares at Cr. $1,50 per hectare. The maximum area which can be purchased by an individual or company is 10,000 hectares or 24,710 acres. The latest law requires that the area selected must have a depth 2 or 3 times its frontage on a river or creek. The land must be surveyed by a registered surveyor or engineer who charges Cr. $1.300,00 to Cr. $1.500,00 per kilometer, assuming that an area having a river frontage of 7,000 meters and a depth of 14,000 meters, as required by law, was selected, such an area would have a perimeter of 42 kilometers and contain 9,800 hectares (24,215 acres). The land would cost the purchaser Cr. $14.700,00 plus Cr. $54.600,00 for the survey or a total of Cr. $69.300,00 or Cr. $7,07 per hectare or 4.4 cents (US) per acre. Neither foreigners or foreign companies can acquire State land, however, companies organized under Brazilian laws, whose capital is wholly or partially foreign can acquire State land provided the Director is a Brazilian.

LOGGING METHODS RECOMMENDED

Owing to the large number of species as well as the erratic nature of their occurrence, the removal of one or two species presents serious logging problems. Indeed, it may cost more to log a few scattered trees than they are worth. Selective logging is therefore impractical. Logging costs can only be reduced by logging all merchantable species on a given area. The writer is of the opinion that a D-6 Caterpillar tractor equipped with

a bulldozer blade for opening roads, a Hyster D-6-N towing winch, and a D-6 logging arch would prove to be the best adapted to the timber and ground conditions of this region. Tree-length or half tree-length logs can be skidded with the above equipment to the river landings where they can be bucked into proper log lengths with cross-cut or chain saws. For distances greater than 1,500 meters it is more economical to use trucks or log wagons pulled by tractors. Tree-length or half-tree-length logs can be skidded with the above equipment to a deposit, bucked into convenient log lengths, and then loaded on light trucks or wagons and hauled to the river landings. Light trucks equipped with trailers can haul average loads of 4.5 m^3. Trucks with a four-wheel drive could probably operate successfully for 2 months longer each year than ordinary trucks. The native woodsmen use round-headed 2-1 2 to 3-1 2 pound axes for felling timber and log making. However, the writer recommends that this wasteful practice be abolished by the gradual introduction of 3½ to 4 pound double bitted axes and cross-cut saws especially adapted for felling and bucking hardwood timber. The introduction of spring boards for felling the buttressed species will eliminate the time consuming practice of erecting temporary scaffolds. Using the above equipment the writer estimates the cost of logging as follows per m^3 Francon:

Felling, bucking, and opening roads	Cr. $ 50,00
Skidding, loading, and hauling up to 12 kms.	Cr. $ 74,44
Total logging cost per m^3 Francon	Cr. $124,44
Total logging cost per m^3 of lumber	Cr. $224,00
Total logging cost per thousand bd.ft. of lumber	US $ 8.26

Twenty percent depreciation was allowed for the tractor, winch, and arch; 50 percent for the truck and trailer; and 100 percent for the tools.

The timber in the swamp and varzea forests can be logged more economically with the pull-boat high lead system of logging.

LUMBER MANUFACTURING PROBLEMS

The logging of all species on a given area presents difficult manufacturing problems. Lumber manufacturing costs are increased by the difficulty and inconvenience of sawing and handling so many different kinds of timber and so are the costs of seasoning, classifying, storing, and distributing the finished lumber also increased. Morototo is similar to basswood in weight and hardness while macaranduba is 55 percent heavier and 108 percent harder than American white oak. A headsaw which has been fitted and adjusted for sawing dense refractory hardwoods is absolutely unsuited for sawing soft light-weight woods without adjustment. The combination of a veneer and plywood plant with a sawmill will greatly aid in solving this problem. The soft light-weight woods can be peeled for utility plywood and the highly figured woods peeled or sliced for face veneers. The smaller and defective logs of the above species as well as the species not suitable for core stock or face veneers can be sawed into lumber. Another possible solution of this baffling problem is to combine a pulp mill with a sawmill and/or a veneer plant. Species which are not of special interest for lumber or veneer could be pulped by a chemical process recently perfected in West Africa for pulping heterogeneous mixtures of tropical hardwoods. Many lumber manufacturers in the United States have found it more profitable to combine sawmill operations with veneer and plywood plants and or pulp mills.

The separation and classification of the species should commence at the river landings. In order to avoid damage by insects, the light-weight species which will float should be dumped into the water immediately and made into rafts for towing to the sawmill, veneer plant, or pulp mill. It may be found advisable to remove the bark from certain

species in the woods or at the river landings in order to avoid insect damage. A rough classification can be made of the heavier species when they are loaded on barges at the river landings. At some sawmills the logs of the heavier species are beached or stowed in shallow water by species at high tide until they are needed. Other sawmills maintain extensive log storage yards where the logs are piled by species with locomotive gooseneck cranes or overhead traveling cranes until needed.

The logs of some species, such as marupá, mata-matá preta, macaranduba, andiroba, and anani *(Symphonia globulifera* L.*)*, show a marked tendency to split. Other species, such as pracuuba, achua, and cedrorana *(Cedrelinga catenaeformis* Ducke*)* possessing interlocking grain, show a marked tendency to warp. This tendency to split or warp is due to internal stresses produced by the high ratio between radial and tangential shrinkage as well as the difference in the rate of shrinkage between the sapwood and heartwood. This difficulty can be largely overcome by sawing the logs into cants on the head saw and then sawing the cants into boards of dimension lumber in a gang saw or gang edger. Owing to the dense refractory nature of some of these hardwoods, the writer recommends the use of a large gang saw, for the head saw, which will saw only cants, and smaller gang saws to saw the cants into boards or dimension lumber. This system of sawing will largely eliminate the use of an edger, although a trimmer will be necessary. The use of a gang saw as a head saw will not permit the sawing of defective logs so as to secure a maximum amount of lumber of the highest grade. As there are many small and defective logs, the employment of a band saw might be more desirable, and in this case an edger as well as small gang saws to handle cants would be necessary.

Using this type of machinery and equipment, the writer estimates the lumber manufacturing cost would be Cr. $508,47 per m^3 or US $18.75 per thousand board feet. The above figures include labor, supervision, fuel, lubricating oil, grease, and the maintenance and depreciaton of the sawmill machinery at 10 percent.

In some localities the writer believes that it will be more economical to mill the timber where it grows and lighter the lumber to a deep-water port than to transport logs long distances in barges to sawmills situated on a deep-water port. Portable mills can be set up on the banks of rivers near suitable bodies of timber and moved up or downstream as the occasion demands. The lumber yards, dry kilns, planing mill, and veneer and plywood plant should be located, of course, at a deep-water port. An LCT or an LCN will no doubt be found very convenient for moving the tractor and sawmill to a new location and for transporting lumber to the shipping port. A river launch powered with a 100 HP Diesel engine will be necessary for transporting supplies to the mill and can be used for towing lighters of lumber. With the proper equipment the writer believes that lumber can be transported to a deep-water port for Cr. $60,00 per m^3 as compared with a transportation cost of Cr. $100,00 to Cr. $150,00 per m^3 Francon for transporting logs from the river landings to the mills. Since logs measured by the Francon measure will yield only 55 percent of their volume in lumber, the saving effected by transporting lumber instead of logs is therefore quite obvious. If logging and sawmill operations were combined with a pulp mill, these combined operations should be located near one of the waterfalls where hydro-electric power is available.

In tropical regions, and particularly during the rainy season, the rate of sapwood deterioration from stain, decay, and insects is extraordinarily high. Water storage is only a partial solution since the exposed part of the logs of some species will stain, decay, or be attacked by insects. Certain chemicals used as sprays or dusts will control the insects and reduce stain and decay. The best solution would seem to be utilization soon after cutting.

LABOR

The minimum wage of Cr. $2.300,00 per month established by presidential decree went into effect on September 16, 1956. All common labor is therefore hired on the basis of Cr. $77,00 per 8-hour day except agricultural laborers. Sawmill mechanics and machine operators are paid Cr. $80,00 to Cr. $150,00 per day in the estuary region. The wage scale of ICOMI S. A., a subsidiary of the Bethlehem Steel Corporation operating in the Territory of Amapa, is as follows: carpenters and bricklayers: Cr. $22,00 to Cr. $32,00 per hour; tractor operators: Cr. $18,00 to $28,00 per hour; and tractor mechanics: Cr. $22,00 to Cr. $38,00 per hour. These workers have been trained by, and are accustomed to work under American mechanics and engineers and are the elite of skilled workers in northern Brazil.

The apparent labor shortage in some regions is due to the higher earnings obtained by them in extracting rubber or macaranduba gum or gathering Brazil nuts or jutacicia resin. These extractive industries are less laborious than felling and bucking timber, hewing crossties, or manual logging. The efficiency of the present labor force leaves much to be desired. All logging operations should be conducted on a piece-work basis as this is the most satisfactory method of handling Brazilian labor. If additional unskilled laborers are required, they can be recruited in almost unlimited numbers in the interior of the State of Ceará.

TAXES

The tax problem is a very important item to be considered by any firm planning to engage in business in Brazil. In the State of Pará all logs, lumber, and crossties produced must pay a Municipal Tax (Industria e Profissao) of 6.25 percent of their official value (pauta) which is usually less than their actual sales value. The State Government levies a sales tax of 3.25 percent *ad valorem* on all sales made within the State as wall as all products exported outside the State. The State also levies an inspection tax of Rs $2,00 per m^3, an export tax of 5 percent *ad valorem*, and an agricultural defense tax of Cr. $7,20 per m^3 on all logs, lumber, and crossties exported from the State. The Federal Government, through the Instituto Nacional de Pinho, levies an export tax of Cr. $5,00 per m^3, a rural economy tax of 2 percent *ad valorem*, and a plant defense tax based on 0.2 percent of the weight of the product exported at 10 centavos per kilo. At present the local taxes per m^3 Francon for logs amounts to Cr. $23,10 for andiroba, to Cr. $55,13 for sucupira, and if exported to other Brazilian States, these taxes amount to Cr. $89,67 for andiroba to Cr. $140,90 for sucupira logs. If they are exported to foreign countries, these taxes increase to Cr. $104,35 and Cr. $116,70 respectively. Andiroba and sucupira lumber exported to foreign countries pay the equivalent of US $6.50 and US $8.88 respectively per M bd. ft. in taxes.

Since no veneers, plywood, or paper pulp are produced in the State of Pará, no official value or rates of taxation have been established for these products. In order to encourage the development of new industries, the State of Pará will grant an exemption of all taxes for a five-year period.

A graduated income tax is levied on individuals and corporations doing business in the country and varies from 3 percent on net incomes of Cr. $60.000,00 per year to 50 percent on net incomes of Cr. 3.000.000,00 or more per year. The following exemptions are allowed: Head of family: Cr. $50.000,00; Wife: Cr. $30.000,00; and each minor child; Cr. $15.000,00.

MARKETS AND PRICES

The market for logs, lumber, crossties, veneers, plywood, and pulp produced in the Amazon estuary region is world-wide owing to its geographical position. The maritime tariffs for shipments made overseas from

Amazon estuary ports are the same as for Belém itself. The local demand for acapú, pau amarelo, cedro, macacauba, and sucupira lumber is greater than the supply available. Of the 9 sawmills situated in the estuary region, 8 sell a large proportion, and in some cases, practically the whole of their production outside the State. The following prices are now prevailing for Amazon estuary ports: Andiroba boards: Cr. $1.829,00 per m³ or US $67.70 per thousand bd. ft.; acapú and pau amarelo boards: Cr. $5.160,00 per m³ or US $190.26 per M bd. ft.; dimension lumber of macaranduba, achua, or maparajuba: Cr. $3.000,00 per m³ or US $110.62 per M bd. ft.; and parquet flooring of acapú, pau amarelo, and sucupira (0.02 x 0.08 x 0.24 m or 13/16" x 2-2/16" x 9-15/16"): Cr. $200,00 per m³ or US $0.29 per sq. ft. The above items are largely exported to Fortaleza, Natal, and Receife.

Sucupira, macaranduba, and andiroba logs are exported to Portugal and some sucupira veneer logs are shipped to Río de Janeiro and Sao Paulo. Río de Janeiro also imports dimension lumber chiefly 3 x 9 inches of macaranduba, maparajuba and jutai-acú. (under the trade name of Jatobá) as well as crossties. There is a fairly large local demand for boxes for packing aguardente, soft drinks, beer, petroleum products, soap, food products, and general merchandise. There is a potential market in South Africa for veneer logs, lumber, crossties, utility and decorative veneers and plywood, and box shooks.

The only lumber exported to the United States at present is hardwood squares 1-5/8 inch x 21 inches for turning billard cue butts. The following woods are specified and the price is about US $422.00 per M bd. ft. for Amazon estuary ports: acapú, sucupira, pau roxo, macacauba, macaranduba, pau d'arco, muirapiranga, and pau santo. The British Timber Control Board have approved the following species for importation: freijó, jacareuba, araracanga, andiroba, pau marfim, cupiuba, mandioqueira, louro vermelho, quaruba vermelho, and sucupira. However, sterling exchange has not been available for their importation in recent years. There is a potential market in West Germany for veneer logs, lumber, utility and decorative veneer and plywood but the prices quoted by Brazilian exporters are too high.

The exportation of crosstides from the Amazon estuary region was initiated about 30 years ago. Crossties have been exported to Spain, Egypt, Cuba, Argentina, and Holland as well as to central and south central Brazil. At present, crossties (0.17 x 0.24 x 2.70 m or 6-1/8" x 9-1/3" x 8'10") are being exported to Spain for US $2.00 each at a special exchange rate of Cr. $52,77 per dollar or Cr. $105,54 each. Crossties of the same dimensions and price are now exported to West Germany at a special exchange rate of Cr. $56,00 per dollar or Cr. $112,00 each.

The Instituto Nacional de Pinho has established minimum prices for the exportation of logs, lumber, hewn timbers, and bolts to foreign countries at a special exchange rate of Cr. $52,77 per dollar. Minimum prices for the same items to be exported to Portugal are fixed in dollars which the Banco do Brasil will also purchase at Cr. $52,77 per dollar. Therefore, quaruba logs cannot be exported to foreign countries other than Portugal for less than Cr. $600,00 per m³ Francon or US $68.00 per M bd. ft. (Doyle-Scribner) and Spanish cedar or mahogany logs for less than Cr. $1.800,00 per m³ Francon or US $203.90 per M bd. ft. (Doyle-Scribner). Assacu lumber cannot be exported for less than Cr. $900,00 per m³ or US $33.18 per M bd. ft. fob Amazon estuary ports. Some andiroba lumber is exported to Portugal at the minimum price of US $42.00 per m³ or US $99.12 per M bd. ft. and sucupira planks at US $56.00 per m³ or US $132.06 por M bd. ft. fob Amazon estuary ports.

REFORESTATION OF CUTOVER LANDS

Reforestation offers interesting possibilities, although in the tropics the climatic conditions are entirely different from those coun-

tries where reforestation has been succesfully carried on. In the tropics there are no checks such as frost to plant diseases and insect attacks; once started they can build up to epidemic proportions which will wipe out attempted plantations. Tropical forests are extremely complex mixed stands and epidemic conditions, either of diseases or insect attacking a single species, would be almost impossible because of the scattered distribution of the species attacked. Plantations of Spanish cedar, and Honduras mahogany in Puerto Rico, Trinidad, and Honduras have been subject to attacks by the twig borer *(Hypsiphyla grandella* Zell.) and certain beetles. Plantations of cedro, andiroba, and Honduras mahogany at the Instituto Agronómico do Norte at Belém, Pará were heavily damaged by the same insect pest. The experimental plantations of Marupá at the same agricultural experiment station are now being attacked by the larva of another moth which girdles the leading shoot causing it to produce a bushy tree instead of a tree with a straight clear bole.

The following species have given excellent results in experimental plantations at the Instituto Agronómico do Norte at Belém: parapara, morototo, angelim commum *(Hymenolobium excelsum* Ducke*)* orelha de negro *(Enterolabium schomburghii* Benth*)*, quaruba brancha *(Vochysia guianensis)*, and jurema *(Mimosa schomburgkii* Benth*)*. These species apparently have no insect enemies or fungus diseases and will probably produce timber of pulwood size in 8 or 10 years or sawlog in 15 or 18 years. Parapara shows exceptional growth on the sandy soil at the Instituto Agronomico do Norte which is, without doubt, the poorest soil of the upland forest type in the State. Morototo is especially promising since it coppices very freely. Dr. Pedro Murca, head of the Botanical Department of the Instituto Agronómico, informed the writer that a plantantion of *(Eucalyptus alba* Reinw.) has been sucessfully established at Marituba Station which is situated 18 kilometers from Belém on the Braganca Railroad. The only other exotic species which have shown promise for planting in tropical America are Burma teak *(Tectona grandis* L.*)* and Burma rosewood *(Pterocarpus indicus* Willd.*)*. At the Experimental Staiton of the United Fruit Co. at Lancetilla, Honduras, teak attained a height of 64 feet and a diameter of 18 inches breasthigh in 16 years. Plantations of this species have been equally successful in Trinidad. Burma rosewood is also a tree of very rapid growth and attains a height up to 85 feet and diameters of 20 to 26 inches in 16 years at Lancetilla, Honduras. Neither species appears to have any insect enemies or is subject to plant diseases. The latter species is known in the international timber trade as Narra when exported from the Philippines and as amboyna-wood burls from the Malayan Archipelago.

The reforestation of cutover lands with Brazil nut (Castanha do Pará), Paradise cream nuts *(Castanha sapucaia)*, or cumarú trees also offers interesting possibilities. Budded stock of Brazil nut trees commerce to bear 8 or 10 years after planting and paradise cream nuts in 4 years. The cumarú tree produces the fragrantly scented seeds known as tonka beans. These beans contain a white crystalline, vanilla-flavored substance called coumarin which is used to add fragrance to tobaccoes, soaps, liqueurs, confectionary and bakery products, and as a ingerdient in perfumes, sachet powders and cosmetics. In Trinidad tonka bean trees commence to bear during the fourth year and attain full production the sixth year after planting. The Instituto Agronómico do Norte has developed a hybrid cumarú which commences to bear the second year after planting. Cumarú beans are now quoted at Cr. $55,00 per kilo (2.2 lbs.). Besides yielding nuts or beans, castanha do Para, *castanha sapucaia*, and cumarú are valuable timber trees.

The only species recommended for planting in the swamp forests is ucuuba branca *(Virola surinamensis* (Rol.) Warb.). The kernels of the fruit contain a light yellow vege-

table tallow of the consistency of beeswax. The seeds are exported and the tallow is used in the manufacture of fine toilet and shaving soaps under the trade name of ucuuba butter. The late Paulo Le Cointe informed the writer several years ago that ucuuba branca is a tree of very rapid growth and commences to produce fruit the sixth year after planting. He further stated that a plantation of 144 ucuuba trees per hectare would yield about 3,600 kilos of vegetable tallow per hectare or 3,207 lbs. per acre. Ucuuba seeds are now worth Cr. $5,00 per kilo. The harvesting of the seeds presents no serious labor problem as they will float and the plantation can be enclosed with a light boom and the seeds dipped out at the upper end on a rising tide and at the lower end on a falling tide. The wood of ucuuba branca is suitable for utility lumber and plywood.

PROMISING FIELD FOR INVESTMENT AND DEVELOPMENT

The upland, and in some sections the lowland, forests of the Amazon estuary region offer the most promising field for investment and development the writer has encountered in his 37 years experience in South America, which includes south central Brazil, northern Paraguay, eastern Bolivia, and western Ecuador. It is true that the sawmill operations of the Cia. Ford Industrial do Brasil on the Tapajos River about 28 years ago were not financially successful although highly skilled personnel were brought from the United States. The argument is therefore advanced that the tropical hardwood forests of the lower Amazon Valley are not adapted to American logging and sawmill methods. However, economic conditions are not the same today as they were 28 years ago. At that time there was no world-wide demand for crossties for which a number of Amazonian timbers are admirably suited. The technical properties of these timbers were then unknown, and an attempt was made to introduce them into the United States as general utility woods for which many of them were unsuited. Furthermore, the mill installed was too large and it was very difficult to keep it supplied with logs although a logging railroad was built and track-type tractors were used for skidding logs to the railroad. However, the stands of timber were not heavy enough to warrant the construction of a logging railroad.

Owing to the diminishing supplies of hardwood timber, American consumers of hardwoods will soon be obliged to employ tropical hardwoods to a greater extent than formerly. The enormous demand for certain domestic hardwoods has created a scarcity of material of high quality and large sizes. Furthermore, tests conducted by the Yale School of Forestry in cooperation with the U. S. Navy Department have revealed that many Amazonian hardwoods are greatly superior in physical and mechanical properties to most U. S. species. Finally the relatively limited number of U. S. hardwoods do not possess the physical and mechanical properties which render them suitable for all uses where wood is the logical material to be employed.

The exchange situation is extremely favorable for investment in Brazil. The dollar in the free market is worth 64 cruzeiros as compared with the official exchange rate of Cr. $18,82 per dollars. Any foreigner entering the country can bring in machinery, trucks, tractors, tools, etc. at the free exchange rate. Foreign companies established in Brazil are permitted to remit 8 percent of their annual profits abroad at the official exchange rate. Sawmill, veneer plant, and pulpwood machinery can only be imported as additional capital under an import license at a very high exchange rate. Finally, in order to stimulate export of logs, lumber, and crossties, the Federal Government permits the banks to buy the foreign bills of exchange at special rates of Cr. $52,77 to Cr. $56,00 per dollar.

As everywhere, any business enterprise to be successful in Brazil requires proper or-

ganization and equipment, efficient management, and adequate capital. The writer believes that a sawmill in the Amazon estuary region combined with a veneer and plywood plant and or a pulp mill will be able to meet competition from all quarters owing to the cheapness of timberlands, the abundance of timber of high quality, and to its geographical position — water transportation being available from the forests to the world's markets.

Forest Policy and Legislation

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PRINCIPLES REGARDING THE FORMULATION OF A BASIC FOREST POLICY

INTRODUCTION

The English term "forest policy" is generally translated as "política forestal" in Spanish. It is suggested that a translation which would convey the true meaning would be "póliza forestal".

"Política forestal" suggests something which is liable to change with the politics of a country. We all know how the political outlook of a country may change from time to time, from Right to Left, Republican to Democratic, Conservative or Laborist and vice-versa, depending on the political party which has received the mandate of the people to form the government; of how quickly one politician may follow another in a ministerial post, even under the same political regime.

Non-liability to frequent change, in other words, continuity, is a cardinal principle of a sound national forest policy. This should be considered therefore, as a subject on a plane above that of forestry politics.

It is true that a national forest policy, in the first instance has to be made, and consequently if necessary, has to be reviewed by whichever government is in force, but the policy which it makes or revises, will be sound and have a chance of permanency only if the makers are sufficiently disinterested to rise above selfish motives and party politics. This may not be easy in a country where the population is not forest conscious and fears that the introduction of a forest policy may restrict privileges, or in a country where the forests are mainly owned by private individuals who hold great influence and who fear that the introduction of a forest policy may reduce the profits which they obtain from their forests. In such cases, forestry is not a popular subject, that is, carries no votes, and the minority who are forest or conservation conscious, will have an uphill battle before a forest policy becomes a reality. However, policy makers can be inspired, as illustrated by the Magna Carta signed in England on 15th June 1215, the Constitution of the United States dating from the summer of 1787, and much more recently the Charter of the United Nations, all of which affirm that the individual is entitled to certain rights and liberties in society. These charters are so clear in the first principles which they enunciate that they remain virtually unchanged from the form in which they were drafted, and most people will agree that they are valuable safeguards to human rights and liberties. A national forest policy, if sound, should have the same properties of clarity and permanency and be a safeguard. Once made it should never be subject to change only on political reasons, and it should not require change except at rare and long intervals when its revision may be necessary owing to changed social and economic conditions.

DEFINITION OF A FOREST POLICY

A forest policy may, therefore, be defined as a declaration of first principles which should control the relationship between:

1. The forests existing or projected

2. The physical conditions of the site, occupied or to be occupied by the forests. in particular from the aspects of soil and water conservation
3. The population dependent upon these forests and the physical conditions of their sites

If a forest policy achieves and maintains a harmonious relationship between these and thereby safeguards them, it may be considered as sound. A well balanced relationship can be created and maintained only if the forest policy aims at the greatest good to the maximum number, which is, therefore, another cardinal principle of a sound national forest policy. This may mean restriction on the owner, whether the state or a private individual, in the management of the forest, or on the population who live in or near the forests as regards the produce which they obtain from them. Forest produce being bulky, the population who live in or near forests are in a more favorable position to profit directly from the produce. If this population can utilize all the produce profitably, so much the better from the economic point of view. Other things being equal, it is always more economic to site industries based on forest products as near as possible to the forests, but often there are larger, but more distant populations who are equally dependent on the same forests for produce, consequently the forest have to cater to both. In such cases a forests policy has to decide the principles which should apply to the distribution of the produce between these populations. Or take the case of a river which has its source in one country or state, but on its way to the sea passes through one or more other countries or states, where the waters of the rivers are essential for irrigation. Examples are the Mississippi river of the U.S.A., the Nile river in Africa, and some of the larger rivers of India such as the Godavari and the Mahanadi. Obviously the forest policy applied at the upper end of the river system is of vital importance to the welfare of the populations at the lower end of the river system, perhaps hundreds of miles away. Such cases call for integration in the respective national or state forest policies.

KINDS OF FOREST POLICY

When foresters talk of forest policy they usually mean national forest policy. The conservation and rational exploitation of the forest resources of a country in order that they may fulfil their various protective and productive functions in the best possible way, are obviously in accordance with the cardinal principle of greatest good to the maximum number of inhabitants of the country. It is desirable that a national forest policy should be written and published for general information and appreciation of its objects. Individual forests of a country may be privately owned. Such owners generally have a policy of their own, a private forest policy, seldom written but only carried in their owner's head, unless the owner has had a management plan prepared in which case the policy is recorded in the plan. Management has been described as the practical application of policy to an individual forest. A private forest policy naturally considers the interest of the owner and is not concerned with the interests of others, unless it is coordinated with the national forest policy. When a private owner manages his forest according to the policy of producing a maximum sustained yield of its products, in most cases this could come within the framework of the national forest policy, and the state would not be justified in interfering. When, however, a private owner adopts a policy, for example, selective felling of all stems of a particularly valuable species leading to the extinction of this species, or wholesale liquidation of his forest for immediate gain, regardless of the effect this would have on the general welfare, the State would be fully justified in intervening and taking action to insure that the owner adopted a policy in accordance with the national policy. In a country with a highly developed forest con-

science, forest owners will naturally adopt a policy acceptable to the State, but in other countries an inducement offered by the State to private owners to manage their forest on sound lines, might be, exemption from taxation on forest land occupied by managed forests, or loans at low rate of interest for protection and cultural operations. These may be more effective than regulations prohibiting certain acts in private forests.

Then, as just mentioned, there are cases when integration of national forest policies is desirable. In this modern age there are few countries which can afford to be completely independent of the products or completely insensitive to the needs of other countries. Some countries are deficient in forests perhaps because the soil is valuable for agricultural purposes and the natural forests have been cleared or perhaps because they are naturally deficient. El Salvador and Uruguay are countries of this nature. Other countries have forest resources to produce certain processed articles. The modern economic tendency is in the direction of regimental trade agreements and integration of national forest policies. Such integration leads to regional forest policies or even world policies. Such policies may cover only certain aspects such as production, that is, problem of supply and demand of timber and other produce; protection of soil, water and wild life; control of pests which have no respect for international boundaries; and the coordination of forest training and research. Regional forest policies and world forest policy can come into existence only through mutual desire and agreement, but international organizations, such as the C.A.S. in this hemisphere and the F.A.O. of the U.N. on the world plane, are in the best position to help its member countries should they desire to integrate their national forest policies. Sir John Bold-Orr, the forest Director General of the F.A.C., in the introduction to the F.A.O. Forestry Division Report on the world situation 1937-46 regarding forestry and forest products said in 1946:

> To state the world's problem in broad terms is not difficult. There is a shortage of wood, despite the fact that the world has more than enough forest soil to provide for the earth's peoples even under an expanding economy. The remedy, too, is clear. The forest must be managed as perpetually renewable crops. Waste must be reduced. Legislation must be invoked and the forces of education mobilized to protect the forests from fire and destructive exploitation.
>
> Afforestation must be undertaken on a scale never before dreamed of to create forest values in areas now barren, and to restore millions of hectares lost to agriculture. The two thousand million hectares of forest that still remain untouched must be converted into economic and social assets. The number of trained foresters must be increased many times.
>
> A comprehensive world forest policy must be directed towards a dual goal: first, sufficient forest areas to ensure the benefit of their protective influences, and second, a permanent and abundant supply of forest products.

It is significant that the protective aspect of forests is mentioned before production. Forests are essential for the preservation of basic soil and water resources to prevent soil erosion, and to regulate the flow of water in streams. Without this protection, agriculture, food production and human habitation cannot thrive.

WHEN SHOULD A NATIONAL FOREST POLICY BE FORMULATED AND WHY

To the question when should a country formulate a national forest policy there can only be one answer: with the least possible delay.

In the past, unfortunately, few countries have felt the need for a national forest policy until an advanced stage in their history and then only as a result of dire necessity, when the population has increased, the original virgin forests have been exploited to the

extent that they are no longer able to satisfy the requirements of the inhabitants, and the balance of nature has been upset by man's increased demands on the soil and water resources. Prior to this stage, there may have been attempts by private owners to preserve their forests for specific objects, for example, the reservation of forest tracts by rulers for hunting purposes. These attempts cannot be described as national forest policy as they neither considered the physical conditions of the locality nor the social and economic welfare of the people dependent on these forests, but unintentionally they may have served these purposes. In effect, they were an expression of the will of the ruler to preserve the forests and were first attempts at forest management without the guidance of a declared forest policy.

There are still countries with small populations and surplus forest resources which refuse to profit by the experience of other countries by formulating forest policies before necessity forces them to do so, and such countries can only be considered as immature in their forestry development. The earlier a public policy forest conscience develops in such countries and demands the formulation of a national forest policy the better will it be for them and the smaller the amount of lost ground will they have to regain. It is particularly desirable in such countries, judging from the experiences of the past, that a national forest policy be formulated before the remaining tracts of original forest are opened up by improved communications, which otherwise are followed by unrestricted exploration.

It may be said that the most prosperous countries with the highest standard of living today are those countries which have an adequate area of forest per capita, where forests are considered a great national asset and which have national forest policies such as Switzerland, countries around the Baltic Sea, Denmark, Sweden and Finland, Canada and the United States.

Why should a country have a national forest policy? One might as well ask, why has a ship setting out on a voyage a compass and sailing instructions, why has a religion a creed, a country a constitution, an international organization such as the United Nations a charter? A national forest policy is essential to give purpose and direction to the forestry affairs of a country.

The fundamental aims of the Food and Agriculture Organization of the United Nations, expressed by its motto "Fiat Pannis" are:

1. To increase the production of food materials
2. To improve their distribution
3. To reduce preventable waste of such materials and thereby bring about higher standards of living for the people of the world, particularly in countries where they are low in comparison with those of other countries.

These aims can only be achieved by a national utilization of the natural resources through which food materials can be produced, namely soil and water, which should always be considered as the basic natural resources of a country, since they are essential for life.

Both agriculture and forestry are the principal users of these basic resources This explains why the Forestry Division is one of the divisions of the Food and Agriculture Organization and why in many countries forestry is the responsibility of the Ministry of Agriculture. Both national agriculture and forest policies call for close coordination. A country needs a national forest policy to achieve this close coordination with agriculture and thereby ensure that the basic soil and water resources are used to the best advantage.

GENERAL FEATURES OF A NATIONAL FOREST POLICY

Some of the general features of a sound national forest policy have been mentioned already, such as, stability, that it should be a declaration of first principles controlling the relationship between forests, the physical

conditions of their sites and the populations dependent on them, that it should aim at the greatest benefit to the maximum number of people, which in some cases may render it necessary to integrate the national forest policy with a regional or world policy, and, that in coordination with agricultural policy it should ensure the rational utilization of the basic soil and water resources

The feature of stability calls for some further explanation. It has to be stable, not liable to change on political grounds, because it refers to forest crops which mature only after long periods, perhaps a century or more, and the results of a forest policy can become fully apparent only after many years. On the other hand, if social and economic conditions change, there need be no hesitation to revise the national forest policy to provide for the changed conditions. This point can be illustrated by considering the national forest policy of India. The forest policy declared in 1894 was the first written forest policy issued by a government outside Europe and its principal aims were:

1. To safeguard the forest for the public benefit
2. To preserve a balance between the claims of agriculture and forestry on the available land
3. To satisfy the requirements of the agricultural population for forest produce (mainly small timber, fuel and pasture) to the maximum possible extent without causing deterioration or destruction of the forest

The general principles were so essentially sound that this policy remained in force for 50 years. By 1944 it was decided to revise this policy for three principal reasons:

1. The great social development which had taken place in India in the meantime
2. The importance of the forests of India in the 199-45 war had focused attention to their value for industry
3. The development of a better appreciation of the value of land and water resources to the country, largely through the lead given by the U.S.A. in conservation

Consequently the revised national forest policy of India which was finally issued on May 12, 1952 is based on six permanent needs of the country, namely:

1. The need for evolving a system of balanced and complementary land use, under which each type of land is alloted to that form of land use under which it would produce most and deteriorate least
2. The need for checking:
   a) Denudation in mountainous regions on which depends the perennial water supply of the river system whose basins constitute the fertile core of the country
   b) The erosion progressing apace along the treeless banks of the great rivers leading to ravine formation and on vast stretches undulating wastelands, depriving the adjoining fields of their fertility
   c) The invasion of sea sands on coastal tracts, and the shifting of sand dunes, more particularly in the Rajputana desert
3. The need for establishing tree lands, wherever possible, for the amelioration of physical and climatic conditions promoting the general well being of the people
4. The need of ensuring progressively increasing supplies of grazing, small wood for agricultural implements and in particular of firewood to release the cattle dung for manure to step up food production
5. The need for sustained supply of timber and other forest produce required for defense, communications and industry
6. The need for the realization of the maximum annual revenue in perpetuity consistent with the fulfilment of

the needs enumerated above

The general features already mentioned and the above considerations of the national forest policy of India draw attention to another two general features, namely:

1. That a national forest policy must be in consonance with the social and economic development of the country. To take two extremes — the national forest policy desirable for a country with extensive forests in undetermined ownership or in nominal possession of tribes, and not subject to exploitation other than shifting cultivation, would naturally be much simpler than one desirable for a country with a limited area of forests whose ownership by the State or private individuals has been determined by a large population perhaps living mainly in cities and a high degree of industrialization, even though the underlying principles would be the same.

   The extent and ownership position of forests, the intensity and distribution of population, the social customs and industrial pattern of a country are all liable to change. Consequently, when a national forest policy is laid down for the first time, or revised, current social and economic conditions must be taken into account.
2. That a national forest policy should provide both for the protective and productive functions of the forest of the country, and that the former should be considered as the more important.

   As regards the productive functions of the forests, a national forest policy cannot go wrong if it aims at sustained yields of produce from all forests of the country.

FUNCTIONS OF A STATE FOREST SERVICE IN A NATIONAL FOREST POLICY

It is most desirable that a government should consult the best professional talent available in the country on matters of forest policy before these are laid before the legislative body of government for open debate and ratification. It is on such occasions that the chief officers of a State Forest Service have an opportunity of shaping the national forest policy in accordance with the principles of their profession. They are specially to advise government on the subject as apart from their professional training, they represent the instrument of government through which a national forest policy will be applied. It would be unwise for a government to fail to place a correspondingly high value on their advice.

As well as advising government on matters of forest policy, and being the instrument of applying a national forest policy, a State Forest Service has another important duty to perform in connection with forest policy, namely, striving its utmost to develop a forest sense among the non-professional public in order that forest policy may be understood by the general public and have its support.

FUNDAMENTAL PRINCIPLES OF A FOREST POLICY

As a result of the recommendation made in the 2nd World Forestry Congress in 1949 to the effect that the F.A.O. should prepare a statement of forestry principles for the consideration of member countries, the following principles governing the formulation of a basic forest policy were unanimously approved in the 6th Session of the Conference of Food and Agriculture Organization held in Rome in November-December 1951, vide Resolution No. 26 of that Conference. The Conference:

> Declares its conviction that the forest is a factor of prime importance in the economic, social and physical balance of the world. Subject to wise conservation and utilization it constitutes an indefinitely renewable source of products which are indispensable to man. The development of standards of living and the growth world population creates even greater needs for such products and many countries insufficiently endowed with

forest resources must therefore depend upon other countries for supplies. Also because it provides or can provide employment for many workers, and is a source of raw material for a wide variety of industries, the forest constitutes an important element in the social stability and progress of the world. The forest also exercise vital protective functions in regard to soil, water and climate and as a result influences the agricultural economy, the development of hydro-electric industries, and the general welfare or rural and urban peoples, both in the country itself and in neighboring countries.

Both the protective and productive functions may well be visited by destructive and careless practices. In order to enjoy to the full all the benefits which the forest can afford, both to the country itself and the world at large, it is essential that each country should formulate a sound forest policy.

Recognizes that the forest conditions may vary widely country to country. Great differences exist in the forms of forest ownership. Economic exploitation of the forest and efficient utilization of its products necessitates the application tion procedures suitable to varying conditions. Bearing in mind however, that there are certain basic principles which govern for any country both the formulation and the implementation of an adequate forest policy.

Recommends therefore to governments the adoption of the principles outlined below:

1. Each country should determine and set aside areas to be dedicated to forests, whether at present forested or not. This should be done progressively if necessary, but always in accord with the country's economic and social policy, and taking into account the close interdependence of all forms of l and use.
2. Each country should apply the best practicable techniques in seeking to derive in perpetuity for the greatest number of its people, the maximum benefits available from the protective, productive and accessory values of the forest. This implies that:
   a) protection should be afforded against damage or destruction by man, or by such causes as fire, insects and tree disease.
   b) production should be organized in quantity and quality, with a view to obtaining at least a sustained yield as soon as practicable, giving consideration first, to any protective role assigned to the forest and then to any other interests, whether worldwide, regional, national or local, that the forest should serve.

      The country concerned must itself adjudge priorities taking into account that a forest may be called upon to render multiple services, including offering recreational values, protection for wild life and a source of supply of many kinds of produce.
   c) economic and rational methods of forest cultivation and of conversion, and the utilization of forest products should be encouraged, so that the volume and variety of commodities obtained from the raw material furnished by the forest shall be increased to the maximum extent possible.
3. Adequate knowledge of all aspects of forest resources, forestry and the consumption and utilization of forest products, is indispensable.

This includes in varying degrees at the different stages of development of forest policy, a knowledge of the resources available on forested lands; of the national needs for forest products; of the national laws that apply to forests; and of the techniques employed in the

production of forest crops and the utilization of their products. To this end, research should be organized to keep pace with all development in the field concerned, and the application of the results obtained should be consistently encouraged.

4. Public consciousness of forest values should be developed by all means possible.

Following those recommendations, considerable progress has been made in the field of forest policy. The recommendations have been accepted by all governments; some governments, such as that of India, have revised their national forest policy in accordance with the general principles; other governments with the assistance of advisers made available by the F.A.O. at the government's request have established a national forest policy following these principles; the line which regional forest policy should take in certain special fields has been indicated, such as conservation in Near East countries where pasture of livestock is a main factor, and timber production and consumption in Europe where there is a large population and not much margin between available supplies and demand. Regarding policies, mention must be made of the recommendations made in the 5th Session of the Latin American Forestry Commission held in Caracas, Venezuela in October 1955. These recommendations are as follows:

1. That all the goverments of the member countries take a special interest in the timely presentation of the Forest Policy Reports.
2. That in the preparation of these reports the countries follow, as closely as possible, the outline established by the Secretariat of the Commission.
3. That the forest legislation of the member countries endeavor to establish the necessary procedures to clearly define the forest lands and their demarcation.
4. That the governments of the member countries pay preferential attention to the better organization and efficiency of forest services, endowing them with adequate funds and technical personnel.
5. That the goverments, notwithstanding their attention to forestation and afforestation programs should not neglect the utilization and protection of the natural forests.
6. That the importance of forest activities for the effective development of the forest program is recognized.

Regarding 2 the outline form of Forest Policy Reports was sent by the Secretary of the Latin American Forestry Commision to all member governments on July 18, 1956 with the request that the Forest Policy Reports for 1955 and 1956 be prepared in this form for consideration in the 6th Session of the Latin American Forestry Commission. The outline form contained the following main heads:

1. Introduction
2. Present position with regard to forest policy measures
3. Statistics
4. Improvement of forest production
5. Forest products utilization
6. Research
7. Forest labour
8. Trade
9. Professional training
10. Publicity and extension
11. Miscellaneous

DEDICATION OF CERTAIN AREAS TO FOREST COVER WHETHER PRESENTLY FORESTED OR NOT, FOR WATERSHED PROTECTION, TIMBER PRODUCTION, ETC.

The first fundamental principle recommended in the 6th Session of the Conference of the F.A.O. held at Rome in November-December 1951 dealt with this subject.

The recommendation made it clear that the dedication of certain areas in a country to forest cover is essential, but very properly left it to the member country to determine which areas should be dedicated. Further, it recommends that the dedication should be

done progressively, if necessary, but always in accord with the country's economic and social policy, and taking into account the close interdependence of all forms of land use.

The reason the recommendation could not be more specific is that the area to be dedicated should depend on local circumstances such as climate, topography and soil, as well as the relationship between the extent and distribution of forests on the one hand and the intensity and distribution of populations on the other hand.

To prescribe that a fixed percentage of the country's total area should be dedicated to forest cover serves as a rough guide to show what is considered desirable for the country as a whole. Most foresters are in general agreement that it is desirable that from 20 to 30 per cent of the total area of a country should be under forest, but the chances that such a percentage can be applied equally to the several parts of a country are very remote, as local circumstances vary from portion to portion. This is particularly true in the case of a large country such as India, or a long country with a great range of lattitude as Chile. The existing forest policy of India aims at the following percentages in the full realization that its proportion of land to be kept permanently under forest must vary in different regions:

1. For India as a whole the aim should be to maintain 33 per cent of its total land area under forests.
2. As an insurance against denudation a much larger percentage should be kept under forests for their protective functions in mountainous tracts such as the Himalayas and the Deccan, liable to erosion, about 60 per cent of the land of each of these tracts.
3. In the plains, where the ground is flat and erosion normaly is not serious, the aim should be to maintain about 20 per cent of the total land area of these tracts under forest. Further in view of the pressure of agriculture in these tracts, this 20 per cent forest area should be situated as far as possible on river banks, roadside, pieces of waste land and other convenient places not suitable for permanent agriculture aiming at distributing this forest area as evenly as possible over the plains in order that they may serve the requirements of the populations as conveniently as possible. In parts of the plains where the forest area is deficient, that is, less than 20 per cent, afforestation should be understaken to make up the deficiency, siting those plantations on marginal lands, as well as the sites indicated obove.

Another reason the FAO recommendation did not specify a fixed proportion but left it to member countries to determine, is that there are wide variations in the actual extent of forest, the proportion which the forest area bears to the total area, and the area of forest per inhabitant between countries. This point may be illustrated by a few figures from the FAO publication "World Forest Resources, March 1955." See Table # 1.

Region	Total area of forest (million hectares)	Percentage of total area of the region	area of forest per inhabitant (hectares)
Europe	136	28.3	0.3
U.S.S.R.	743	33.9	3.8
North America	656	36.1	4.1
Latin America	890	39.7	5.2
Africa	801	27.0	3.9
Asia	525	19.8	0.4
Pacific Region	86	19.0	6.7
Total	3837	29.1	1.6

Country	(thousand hectares) Total area of forest	Percentage of total area of the country	area of forest per inhabitant (hectares)
Canada	341.963	38.1	23.7
U.S.A.	252.230	32.8	1.8
Mexico	25,856	13.1	1.0
Guatemala	5,450	51.2	1.9
El Salvador	721	36.8	0.4
Honduras	4.874	43.8	3.3
Nicaragua	6,450	47.1	5.9
Costa Rica	3,925	78.3	4.6
Panamá	5.270	69.8	7.2
Jamaica	197	17.3	0.15
Puerto Rico	129	14.5	0.06
Trindidad and Tobago	261	60.8	0.4
British Guiana	18,100	92.0	40.8
Liberia	8,900	81.7	5.4
Thailand	32,129	77.2	1.6
Argentina	70.000	25.2	3.9
Bolivia	47,000	44.0	14.5
Brazil	480.195	56.7	8.6
Chile	16,300	22.1	2.8
Colombia	69,000	61.5	5.7
Paraguay	20,906	54.0	14.3
Peru	70,000	62.0	7.9
Uruguay	486	2.8	0.2
Venezuela	4,542	5.1	0.9
India	70 979	21.6	0.2

The dedication of areas to forest is necessary for two purposes — protection and production:

Protective forest areas — The area required for protection such as watershed protectoin, prevention of erosion in mountainous countries, and fixation of loose sandy soil on inland plains and coastal tracts should depend on the local circumstances of climate, topography and soil. A forest cover may be required also for other forms of protection, such as shelter for crops and livestock against wind and protection of wild life.

Though the selection of areas for dedication to forest cover for protective purposes must depend on local circumstances, the protection desired may affect the welfare of populations over wide tracts which may extend into adjoining countries.

The selection of areas for dedication to forest cover for protective purposes should be done by a joint commission composed of members representing all connected interests, namely land use and conservation, agriculture, forestry, ecology, hydroelectricity and communications, and if the protection will extent to other countries the governments of those countries should be consulted also.

Such selection can be effected only tentatively unless accurate maps, particularly topographical maps, of the country are available. Consequenly, the preparation of such maps when they do not exist, should be given very high priority on a national plan for development. If such maps are not available, the selection can only be made, and the boundaries of the selected areas marked on the ground pending the preparation of maps, when the final selection may require some revision.

The existing forest area of a country may be less than the minimum area considered necessary for protective purposes. In such cases the existing forest area will have to be supplemented by the dedication of additional non-forested areas and the national forest policy will have to provide for placing the additional non-forested areas under forest cover at the earliest possible date according to the availability of funds and the manpower needed for afforestation.

Productive forest area — The dedication of areas to forest cover for production should depend on a combination of physical and economic factors, the latter being the more im-

portant. For example, certain areas owing to their remoteness or soil condition, may be more appropiate for forestry use than agriculture. Conversely the soil of a country may be so useful for agriculture that it is more economic to the country to devote it to agriculture, cultivation or pasture, and to import timber from another country. El Salvador and Uruguay are countries of this nature.

Among the economic factors which will affect the dedication of areas to forest cover for production, are the extent, nature and distribution of the existing forests, the intensity and distribution of population in relation to the existing forest, the quantity and nature of forest produce required for internal consumption, both domestic and industrial, and the prospects of foreign trade both exports and imports.

The selection of areas for dedication to forest cover for production will be facilitated greatly if accurate physical and economic maps, and accurate statistics, specially forestry statistics, area available. These are seldom available in a country where scientific forestry has not been practiced, but a preliminary selection may be made based on such information as is available, so that the areas selected may have their boundaries marked on the ground if necessary, and may be managed for production under the provisions of the national forest policy.

A case of this nature is illustrated by India in the last quarter of the 19th century. As the forest areas were gradually selected, settled and demarcated for constitution as Reserved Forest, maps became necessary. The Inspector General at the time, late Sir William Schlich, comprehended this need and moved the government of India to set up a separate Forest Map Branch of the Survey Department with the result that excellent maps, mainly on 4 inches — 1 mile scale, became available for most of the Reserved Forests by the end of the century. These maps have been the foundation of sound management of the forests of that country.

Economic and social conditions of a country are liable to change. For example, taking the simplest case, a population may increase, exerting more pressure on the land for cultivation and on the available forests for their produce. Or a predominantly rural population may become industrialized, at least in part, when its requirements for forests products may greatly change in volume and in character. The increased productivity of forests under management, or the opening up of hitherto inaccessible forests by improvement of communications may be sufficient to meet these demands, otherwise it may become necessary to dedicate additional areas to forest cover for production.

The selection of areas for dedication to forest cover for production has to be subject to constant review and revision to remain in alignment with economic and social factors. For this reason, the third of the fundamental principles of forest policy recommended by the FAO is an adequate knowledge of all aspects of forest resources, forestry and the consumption and utilization of forest products. Without up to date knowledge of these it is difficult to estimate the extent of forest area needed for production, even for existing requirements. For future requirements a national forest policy has to attempt to anticipate these as far as possible by a consideration of the trends of population, consumption and forest productivity, since forest crops may take years to mature. With this knowledge a national forest policy is in a position to justify the estimate of the extent of forest area, by types and qualities, required for production.

The FAO annual publication "Yearbook of Forest Products Statistics" and the 5-yearly publication "World Forest Resources" have proved most useful in providing data for the formulation of regional and world forest policies.

As the figures quoted above from "World Resources 1955" show there are great variations between countries in the extent of forest area per inhabitant — to take two extremes Puerto Rico only has 0.6 hectare and British

Guiana has 40.8 hectares per inhabitant. There is almost as great a variation in the annual productive capacity per unit of forest area. For example, quoting from "Forestry" by Professor Champion:

1. Temperate zone managed forest of average quality may be expected to produce about 3 cubic meters (oak), 5 cubic meters (beech), 8 cubic meters (spruce) and 14 cubic meters *(Pseudotsuga taxifolia)* of utilizable round wood per hectare per year.
2. Hot dry zone forests may produce 2/3 cubic meters only of utilizable round wood per hectare per year.
3. Wet tropical forests may yield only about the same quantity of utilizable round wood per hectare per year, because at present a large proportion of the material of these forests is not utilized and there is little demand for fuel; however, such forests have a much higher potential.
4. Fast-growing coniferous plantations, such as those of *Pinus insignis* in Chile may produce as much as 20 cubic meters of utilizable round wood per hectare per year.

The same authority has suggested that 0.5 hectare may be taken as the minimum of forest required per head of population living under average conditions, for production. This figure is based on the average production area. However, in view of the great variations mentioned above it is very desirable that a national forest policy should adopt its own figures of forest productivity and of consumption per inhabitant to estimate the minimum forest area required for production.

IMPLEMENTATION OF A SOUND FOREST POLICY

Part II of Resolution No. 26 of the 6th Session of the Conference of the Food and Agriculture Organization held at Rome in November-December 1951 made the following recommendations regarding the principles which should govern the implementation of a forest policy:

5. Forest law to give effect to the forest policy should be enacted in consonance with the juridical forms and customs of the country. Such legislation should be developed in keeping with the economic and social progress of the country, and should, in fact, anticipate such progress.
6. A Forest Service should be established and staffed by suitably qualified personnel in all its grades to develop and implement forest policy in collaboration with any suitable organizations which may exist and to administer the forest law. Such a service should be formed on a permanent basis; it should be endowed with adequate authority and financial support, and should work in close association with other governmental agencies concerned. There should be an effective organization to deal with forest research and the dissemination of results.
7. Adequate training should be provided for all concerned with the management of forests, or the utilization and processing of forest products. In particular, foresters and skilled technicians should be trained in sufficient numbers to staff public services and other interests concerned with forestry and forest products. For the higher grade personnel such training should be provided at schools of university standard, established, to the extent that this is possible, in the country concerned. Subordinate personnel should receive suitable basic training to enable them effectively to fulfil their duties.

These are undoubtely first principles. Forest policy cannot be put into practice unless there is a forest law; to administer the provisions of a forest law there must be a forest service; and the forest service cannot perform its functions properly unless its staff

is adequately trained and endowed with adequate authority under the provisions of the law, and with adequate financial support.

We shall consider therefore, the implementation of forest policy under the three heads of legislation, organization and finance.

LEGISLATION

As stated above, the general aim of forest law is to render it possible to put a forest policy into practice.

In some countries a comprehensive national forest law or act has been enacted prior to the public declaration of their national forest policy, for example, India, where the Indian Forest Act No. VII was enacted in 1878, 16 years before the national forest policy was declared. The preamble or introduction to this act stated that it was an act to consolidate the daw relating to forests, the transit of forest procedure, and the duty leviable on timber and other forest produce.

In most countries it is usual to find that laws dealing only with special aspects of forestry have been enacted before the need for a national forest policy is felt. In such cases it is convenient to bring together all the isolated laws within a comprehensive forest act and to publish a statement of the national forest policy as a preface to this act.

As with policy and all forms of law, the development of forest legislation must be in keeping with the economic and social progress of the people, existing and anticipated. It is important to remember this, as forest legislation, just as forest policy, tends to be restrictive in one direction, that is, restrictive of the acts of omission or commission by individuals if they are against the larger interest of the community or the public welfare.

Forest legislation, like other laws, will work successfully in practice only if it is an expression of the will of the people, that is, its necessity must be understood by at least a majority of the people who are prepared to abide by it. Laws introduced against public opinion will inevitably, sooner or later, become dead letters. Special care is necessary therefore, in framing forest legislation appropriate for a country with a large extent of forests and a small population who are in close contact with the forest and are largely dependent on it. In such countries forest legislation can only be introduced gradually, and at first should confine itself to controlling the activities most obviously against the public welfare such as the destruction of forest cover in watershed tracts by unrestricted clearing and burning, perhaps by shifting cultivation, or by unrestricted grazing, or the wholesale cutting of a valuable species. The forest legislation in this case will not only refer to current activities but will try to provide for the future when the forests will be opened up to improved communications and will be considered as productive sources of material instead of encumbrances on the land to be eliminated as soon as possible.

In framing forest legislation, it has to be remembered that the general form which forest legislation may take depends on the political organization or constitution of a country. Thus in a country with a Central Federal Government and a number of provincial or state governments the constitutional law defines the respective legislative powers. Further, forest legislation is only part of the common law, and must not conflict therefore with other parts of the common law. On the other hand, forests represent a special kind of property with special problems, for example, the mismanagement of a forest may be the main concern of the owner but it may affect many others also. Thus the framing of forest legislation calls for joint action between lawyers who are in the best position to see that the legislation does not conflict with the constitutional and common law of a country, and professionally trained forest officers who are in the best position to appreciate the special problems and who in any case will have to enforce the legislation.

It is important to recognize that it is both impracticable and undesirable for a forest act, especially if it be a national forest act applicable to a large country, to attempt to be too

comprehensive, and to become bogged down by details which may require frequent amendment. The most suitable arrangement in the case of a country with a dual system of government is for the Federal Government to frame a National Forest Act dealing with broad issues only, applicable to all member states, but providing for the issue under the Act of orders and regulations by the governments of member states to meet local conditions. Naturally, such orders and regulations should always be in conformity with the National Forest Act.

The F.A.O. publication, "Forest Policy, Law and Administration" 1950 by Mr. Francois suggests the following as the main subjects which should be given place in a National Forest Act:

1. Definition and classification of the forest lands to which the act applies.
2. Definition of ownership rights and responsibilities.
3. Provision for protection of forests — against abuses by their owners, against third parties and against natural enemies and hazards such as fire.
4. Provision for the establishment of a body to administer the law and definition of its powers and responsibilities.
5. Coordination with closely related parts of the general law, for example, the forest act should be in accordance with all legislation regarding the conservation of basic soil and water resources.

The items covered by each of these main subjects of a National Forest Act will vary with the particular requirements of the country, for example, in one country the prevention of forest fires may be the most important objective, in another the control of grazing, in another the control of timber in transit, in another measures to increase production, but it may be stated that the soundness of a National Forest Act may be judged by the extent to which it provides for the eficient management of all forests of the country, whether they be under state or other form of ownership.

Regarding forest legislation with reference to the areas dedicated to forest cover, it is considered that all areas dedicated to forest cover primarily for protection should be in state ownership to ensure their permanency and good conservation. It is a proper function of the state to be responsible for such areas, since they are to be maintained for the public benefit, an only the state can afford to maintain them since any returns that may be obtained from the sale of forest produce will be purely incidental, and their maintenance may be a financial liability. Such forests should have the same legal status as government reserved under the Indian Forest Act, in which there has been a settlement of rights, no further rights may accrue, and in which every action is illegal unless it is specifically permitted. If such forests are under state ownership and are subject to a strict regime, the conservation of basic soil and water resources under them may be considered as amply safeguarded by legislation, and this conservation will automatically benefit any agricultural lands in the same drainage basin but at lower altitudes than the forests.

In most countries, however, there will be other classes of forests, namely:

1. Areas which are dedicated to forest cover partly for protection and partly for production.
2. Areas which are dedicated to forest cover entirely for production.
3. Forest areas which are not dedicated, that is, not considered essential for protection or production, but are still under forest, perhaps because the country is not yet fully developed.

Any forests falling under classes 1 and 2 and in state ownership should have the same legal status as areas dedicated primarily for protection. Any forests falling under class 3 and in state ownership need a less strict regime, but should be given a legal status similar to that possessed by protected forests under the Indian Forest Act, as such forests may subsequently be needed for expansion of agriculture. On the other hand, it may be

found that when they become more accessible and better known, that portions will have to be dedicated for permanent maintenance under forest, perhaps because the soil quality is too poor for agricultural crops. In other words, portions may need to be transferred from the protected class to the reserved class. The main distinction between protected and reserved forest is that in the former every action is legal unless it is specifically prohibited, whereas in the latter as mentioned above, every action is illegal unless it is specifically permitted.

However, there is no objection to any of the forests falling under classes 1 to 3 being in other form of ownership, commercial or private, provided the National Forest Act legislates for their efficient management, particularly in the case of forests falling under class 1 where protection still is a factor.

The existence of a forest cover is always an aid to good soil and water conservation, especially if the forest be managed efficiently but forest areas under private ownership are more exposed to danger from the lack of attention to good conservation practices than those in state ownership, at least in countries where a forest conscience is not fully developed. In such countries a National Forest Act should contain safeguards at least for forests falling into classes 1 and 2 and preferably for those in class 3 also, in private ownership. The minimum should be the conferment of powers to make orders under the Act, if necessary, to declare certain tracts (which should preferably always coincide with drainage basins) within which private forest owners will have to observe certain precautions in the management of their forests when regulation or prohibition of certain acts appear necessary for purposes such as the following:

1. Protection against storms, wind, floods, avalanches
2. Prevention of erosion on slopes, landslips, formation of ravines.
3. Regulation of stream flow in rivers
4. Protection of roads, railways
5. Preservation of public health

If desired, the relevant section of the National Forest Act conferring the powers to make such orders may go further and indicate the acts which should be regulated or prohibited by those orders, e.g. shifting cultivation, fires and unrestricted grazing, but details should be left to the rules, as conditions will differ from tract to tract.

The National Forest Act should also provide for the making of rules regarding the grant of concessions, assistance or inducement, if necessary, to encourage private owners to observe these precautions.

The above remarks refer to forest areas presently covered or which may be covered but ordinarily the sum total of these areas only represents a portion of the country, and the National Forest Act cannot apply to non-forest areas, that is, areas under agriculture, cultivation and pastures. Ordinarily areas under agriculture are more exposed to erosion than areas under forests. Conservation of soil and water resources within non-forest areas should be covered by a National Agricultural Act or better a National Conservation Act, and so far as these areas are concerned the National Forest Act is responsible only to the extent of seeing that its provisions regarding conservation are coordinated with the National Conservation Act.

The enforcement of forest legislation at all times calls for firmness combined with tact. Further, the forest officers who are charged with its enforcement have a special responsibility in educating the population in order to gain public understanding and support of forestry. This function of educating the public will be rendered much easier if the state owned forests which the forest officers manage offer recreation and other facilities which appeal to the public. Public support of forestry can be promoted by action aimed at convincing private forest owners that efficient management of their forests can be profitable to themselves. This is particularly helpful.

ORGANIZATION

By the time a National Forest Policy is formulated and a National Forest Act enacted, the nucleus of a Forest Service will almost certainly have formed which has been instrumental in crystallizing public opinion and inducing government to formulate the policy and enact the legislation.

Having gained this ground the nucleus will have to begin another task, namely the development of a National Forest Service commensurate with the policy enunciated and the duties indicated by the Forest Act. You will remember that it was stated that there must be a Forest Service to administer the provisions of a Forest Act, also that a Forest Service cannot perform its functions properly unless its personnel is adequately trained, endowed with authority under the provisions of the law and with adequate financial support.

The development of a National Forest Service must be in keeping with the social and economic progress of the country and may take years, but it is worth doing well, and the aim should always be quality, not quantity. The successful application of forestry in a country will depend very largely on the way in which the Forest Service is developed, since, in the exercise of their functions, the members of the service are always in very close contact with the people. Selection of suitable personnel for a National Forest Service is of supreme importance. It is not sufficient to insist on a minimum educational qualification for posts of different grades and categories, but the selection should depend also on other qualities, such as physical and mental constitution, background and character. Forest Service members as well as being practical and resourceful, capable of dealing with situations as they arise, must also be visionaires, looking forward to an ideal of the future which may never be reached in their lifetime (the motto of the I.F.S. is "Mediora speramus" — we look for better things), must be prepared to put up with hardship, to live in remote places if necessary, and to carry great responsibilities regarding the safety of the forests in their charge.

For a National Forest Service therefore, it is desirable that in addition to a minimum educational qualification and a strict physical test, candidates should be approved by a Selection Committee. In India, candidates for the superior forest service were selected by a permanent Public Service Commission consisting of 3 members who might be administrator, a member of the legal profession and a police officer, all senior men with long experience, and a senior forest officer was deputed temporarily to help the Public Service Commission by representing the Forest Service's views and special requirements, and to give the candidate any test considered necessary, such as a walking endurance test.

To attract men with such qualifications to adopt forestry as a career in the National Forest Service it is necessary to offer basic conditions of service, such as permanency, adequate salary and increments, prospects of promotion, leave, pension on retirement and right to appeal in the event of punishment. In view of the great responsibilities which the forestry personnel have to assume, inadequate salaries are a poor form of economy. As regards permanency, a National Forest Service must be developed as a permanent service, not subject to political change, but staffed with personnel from whom a high standard of efficiency, conduct and "esprit de corps" can be expected, and subject to removal from service only on the grounds of inefficiency or improper conduct.

The composition and strength (number of personnel) of a National Forest Service will depend on the duties which it has to perform. Other things being equal, the larger the country, the more extensive and valuable its forests and the more varied the forms of ownership, the larger and more varied should be the forest service. For example, in a country where the bulk of the forests are in a form of ownership, other than state, such as communal or private, the duties of the National

Forest Service will consist mainly in the administration of the forest law, and activities aimed at helping the forest proprietors to manage their forests efficiently, and may only be a small body of professionally trained personnel. On the other hand, a country where the state itself owns forest areas, the duties of the National Forest Service will include direct management of those forests, even the harvesting and sale of the products, and the service may be large. Thus in India where the large area of state forests which existed before 1947 has been made very much larger by the almost complete abolition of private ownership of forests in the past decade, we find that the present area of state owned forests is 283,000 square miles or 22 per cent of the total land area, and the total strength of the Indian Forest Service is now about 80,000 men, including permanent labour force, distributed as follows:

1. Superior Staff	
a) Forest	740
b) Research and other special activities	60
2. Subordinate Forest Staff	
a) Trained	13,000
b) Untrained	18,000
3. Ministerial (office staff, clerical)	6,000
4. Miscellaneous Staff	11,000
5. Permanent labour force	31,000
	79,800

The form of the National Forest Service will depend also on the political organization of the country. In a country with both Federal and State systems of governments there may be both Federal and State Forest Services, the former attending to subjects of national importance such as the overall policy and legislation regarding conservation, production, defense, training, forest research, administration of federal forests; the latter in charge of subjects of local importance, including the management of state forests.

However, the secrets of a successful forest organization are territorial responsibility in all branches and ranks of the service, and a definition of the duties and powers of each rank.

The training of forest personnel for the higher ranks of a Forest Service, that is, training at a professional level is effected in some universities in some countries. This has obvious advantages when the field of employment for graduates in the National Forest Service is sufficiently large, and is essential for the training of men who are to undertake forest research. When the country is small and only needs a limited number of professionally trained personnel, it will tend to economy if this country in collaboration with other small countries with the same language, sets up a common forest school. The Central American republics constitute an excellent example of this, and there already exists forestry schools which cater for the region, namely the I.I.C.A., Turrialba, the Tropical Forest Research Center, Río Piedras, Puerto Rico, and the Latin American Forest Research and Training Institute at Mérida, Venezuela. The graduates of such forestry schools or even other engineering schools may be recruited for service direct to the National Forest Service, or may be selected provisionally for further specialized training at the expense of the government before final selection and taking up duties in the National Forest Service. In other countries, training at a professional level for the higher ranks of the service is effected by the National Forest Service itself. In such cases, the men selected for training are appointed on probation and a major part of the cost of the training is paid by the Forest Service, the trainees entering into a bond to serve the government for a certain number of years after completing the course of training.

The training of all other ranks, that is, training at a level lower than University, can ordinarily be done most appropriately by the National Forest Service. In India there are three types of schools - (1) the Forest Rangers Training College for training of ranger candidates from all states, (2) Foresters Training Schools and Forest Guards Schools,

operated by the Forest Service of the state government. The men sent to the Forest Rangers Training College are selected, appointed provisionally on probation and sent to the college for training at the expense of the respective state government. The men sent to the Foresters and Forest Guards training schools, on the other hand, are men who are already in the permanent service, and who have done at least two years service. They are specially selected on their merit and promise, and deputed for training at the expense of government.

In some countries the National Forest Service has forestry schools and take in men for practical training, who after training may either be recruited for the government service or enter into private service, such as forestry apprentice's schools in the U.K.

The cadre of a National Forest Service should be framed so that it may be possible for a man with ability to rise from a low rank to the highest.

FINANCING

Adequate financial provision for a National Forest Service is essential if the service is to function efficiently. As mentioned, the personnel of a National Forest Service must be paid adequate salaries in view of their duties and responsibilities. Poor salaries and consequently a low morale, render it impossible to build up a strong efficient service. The quotation from the Scriptures that "the labourer is worthy of his hire" is a truism which should not be forgotten.

However, provision for salaries is not the only form of funds necessary — there must be funds also for the operations which the National Forest Service has to undertake.

The finance of a National Forest Service, as with all business concerns, has a credit and a debit side — the revenue and expenditure of the Service.

Revenue represents the income earned by the National Forest Service. There may be many varied sources of revenue, but where there are government owned forests the main source of revenue will be sales of timber and other forest produce. It will be sufficient if the legislature lay down two fundamental principles:

1. All items of revenue, however small, should be paid into the government account at as early a date as possible.
2. No items of revenue, however small, should be used directly for making any form of payment.

In some countries there is a tendency by non-foresters to judge the results of the work of a National Forest Service by the amount of gross revenue earned. As will be seen under certain conditions, there may be no possibility of earning any revenue, and the adoption of gross revenue as the criterion of success is undesirable. Net revenue, that is, the surplus of gross income over expenditure is better, but often the amount of expenditure is a much better indication of whether the National Forest Service is making a useful contribution or not to national development.

Expenditure of a Forest Service comes under two main heads:

1. Establishment — salaries and other allowances
2. Conservancy and works — which may be subdivided into maintenance operations and capital operations.

As has been stated, it is improper to use any items of revenue earned directly for expenditure, consequently funds for the expenditure of a forest service must come from another source. There are three possible sources:

1. From the national expenditure budget — The amount may vary from year to year according to the circumstances, but it tends to efficiency if the expenditure budget is framed for longer periods, 3 or 5 years.

   The forestry legislation may lay down that a fixed proportion of the national budget should be made available for expenditure by the National Forest

Service, or that the amount to be made available should represent a percentage of the income earned by the Service and paid into the government account. The policy or the legislation may indicate also the distribution of funds between the Federal and State Forest Services when both exist.

However, it is essential that finances from this source are sufficient to cover (a) establishment, (b) conservancy and works maintenance. When the National Forest Service has to maintain forests primarily for protection, this may involve a deficit budget for these particular forests, that is, they are a financial liability to government, but on the other hand, they are a social and economic asset. On the other hand, when the National Forest Service has to manage forests for production, the amount of expenditure in maintenance operations to produce should be justified by the revenue earned by the production.

As regards expenditure for capital outlay, a portion of the total funds made available from this source may be alloted for capital work such as new buildings and roads, and the purchase of machinery. In some countries, funds for such expenditure are provided by loans, for example, made available by the Central Goverment to State governments on easy terms of interest and repayment, but in such cases the loan must be justified by the anticipated results.

2. From taxation — This may take the form of a tax on forest products, on exports of forest produce only, or duties on forest products imports.

An important principle is that an amount equal to the proceeds from this source should be allocated for forest development to benefit the taxpayer, which may be the general public or only a portion of the population.

A notable example is the National Forest Fund (Le Fond Forestier Nacional) created in France in 1946 which already has had an important influence on forestry developments in that country. Sixty-four per cent of the forest area of France (20.7 per cent of the total area) is in private ownership. The National Forest Fund was created by law in 1946 to be administered by the National Forest Service (Eeaux et Forêts) to be financed by a tax on forest products. Its main object is close collaboration between the government and private proprietors in the following fields:

a) Expansion of reforestation to repair the damage done by the war and to increase the total forest area.
b) Better arrangements to meet the constantly increasing demand for pulp wood.
c) Better use of land, at present uncultivated and improductive, by putting it under forests.

To achieve these objects the fund may make loans in the form of:

a) Cash advances to private proprietors for reforestation as well as for better conservation of management of existing forests.
b) Materials such as plants from the nurseries maintained by the Eaux et Forést or the use of heavy equipment.
c) Work contracts such as the construction of roads and schemes for protection against fire. In this case the work is carried out by the Eaux et Foréets, and if the work has successful results, the repayment of the loan and interest on it to the fund are shared

between the government and the private proprietor.

The close collaboration between the government and private proprietors has brought about forest restoration in various regions, notably the Landes.

3. Other funds — not resulting from direct taxation but from putting aside annually a portion of the revenue receipts which may be designed in general as forest reserve funds.

These may take various forms according to the purpose for which they are intended, such as:

a) Management reserve fund — to provide for expenditure which could not be forseen, for example, the construction of new roads and bridges to replace those destroyed by floods.

b) Forest improvement or development fund — to provide for improvements or development will increase the capacity of the forests for sustained yield management.

c) Excess exploitation fund — the exploitation of any one year or period may have to be increased for special reasons — for example, a great storm causing extensive windfalls which have to be utilized at once to prevent deterioration, but which will mean reduced yields in some future year or period. The intention of such fund is to ensure that the returns from the excess exploitation will not be misused. They represent a temporary conversion of forest capital into money capital. Only the interest earned by the money capital should be restricted to new capital investment such as reforestation to replace the growing stock which was destroyed.

The forest policy and legislation should indicate which reserve funds are considered necessary, and the amount which these funds should represent, say twice the amount of the average annual gross revenue in the case of a Forest Improvement Fund.

When a country has declared its National Forest Policy, has framed sound legislation, and has an efficient National Forest Service supported by adequate funds for execution of its functions, it will have progressed far on the road of forestry development and conservation of its basic natural resources of soil and water.

La Influencia de los Nudos en la Calidad de la Madera y Metodos para Disminuirlos

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INTRODUCCCION

Se entiende bajo el nombre de industria todos los trabajos destinados a producir materias primas y alimentos, además comprenden la transformación de estas materias en materiales para satisfacer las múltiples necesidades humanas.

Los trabajos industriales se pueden dividir en industrias extractivas e industrias fabriles.

Las industrias extractivas extraen los productos de la tierra sin transformarlos. A este grupo pertenecen la agricultura, la silvicultura, la horicultura, etc.

La industria fabril o manufacturera se dedica a transformar íntegramente las materias primas en productos para satisfacer las necesidades humanas.

Según la clasificación, la silvicultura pertenece al grupo de industrias extractivas, cuya misión es extraer y aprovechar los productos que ofrecen los bosques y los terrenos forestales, o sea, los productos de los árboles como son la madera, la corteza, las hojas, los frutos, las semillas, el bálsamo etc., etc.

Las faenas forestales, como las demás industrias se preocupan de aprovechar y explotar los productos forestales económicamente, es decir, producir más y mejor en menos tiempo. Sin embargo, ésto sólo se puede llevar a cabo cuando los factores de producción están a disposición sin mayores dificulturales. La acción industrial puede ser libre o sujeta a algún factor de producción que puede ser modificado libremente. La industria fabril propiamente dicho es una industria libre. Las industrias que trabajan con factores sujetos a cualquier orden son la industria silvícola, la industria agraria, la ganadería, etc.

Las industrias fabriles tienen gran ventaja sobre las industrias extractivas, pues pueden trabajar libremente con los factores de producción y éstos dentro de cierto límite, lo pueden poner libremente al servicio de la producción. Las industrias sujetas a algún factor trabajan limitadamente y sólo pueden aprovechar las posibilidades que les sean permitidas. Mientras que en la industria fabril la producción dirige sus factores, en la industria extractiva los factores de la naturaleza dirigen y limitan la producción.

Esta gran diferencia que existe entre las industrias fabriles y extractivas da a ambas un carácter particular. Esta es la causa por la cual en la práctica la silvicultura no se considera como una industria, pero como hemos visto, lo es.

PRODUCCION DE MADERA DE CALIDAD

Todas las industrias, como también la silvícola, tratan de producir económicamente. Las industrias fabriles alcanzan este fin llenando las exigencias básicas de la producción económica, producir más y mejor en el menor tiempo. Por lo tanto, los gastos de una unidad serán menores y la diferencia entre el precio de venta y de la producción será mayor. Podemos aumentar considerablemente el precio de venta produciendo mejor calidad, pues es lógico que por un artículo de mejor calidad se obtiene mejor precio.

La industria silvícola trabaja con factores sujetos a un orden, lo que significa que éstas prestan solamente cierto grado de servicio a la producción y generalmente la producción debe adaptarse a estos factores limitados e inseguros.

Analizando lo anteriormente expuesto, se ve que el silvicultor no puede cambiar ni el factor clima ni el factor sitio e igualmente tenemos que considerar las propiedades heredita-

rias de las especies. Igualmente es incapaz de regular, a su gusto, el crecimiento de las plantas. El silvicultor debe trabajar dentro de estos factores constantes y sólo puede modificar y poner al servicio de la producción el capital y la mano de obra.

Las faenas silvícolas se caracterizan justamente por este impedimento que las distingue de las demás industrias.

La producción de las industrias libres es totalmente autónoma. Si se disponen los factores de producción libremente bajo una adecuada dirección técnica, la producción debe ser segura. En la industria forestal sin embargo, la situación es totalmente diferente, en parte porque el silvicultor no puede cambiar, según las necesidades, los factores naturales, y en parte porque son inseguros y fluctúan constantemente. El silvicultor debe estar siempre atento para aprovechar todas las posibilidades que brinda la naturaleza. La producción forestal se caracteriza justamente por esta adaptación y éste es el motivo por el cual las faenas silvícolas no soportan rigidez sino flexibilidad frente a las posibilidades de la naturaleza.

Se comprende que la producción forestal es una tarea sumamente delicada, que exige muchas precauciones, amplios conocimientos y precisión. El trabajo del silvicultor está dificultado por el hecho de que generalmente el fruto de su trabajo es para las generaciones siguientes, o sea, su siembra es cosechada por otros. Esta circunstancia especial obliga al silvicultor a trabajar con muchas precauciones y honradez. Para lograr estas exigencias, lo mejor es producir calidad, pues es seguro que los productos de calidad tendrán siempre buen precio en cualquier época.

Por lo tanto la producción de calidad debe ser considerada como una necesidad en la empresa forestal, pues es el único medio seguro de producir económicamente y satisfacer de la mejor manera las necesidades de las futuras generaciones.

El principal producto de la industria forestal es la madera. Los otros productos del bosque, como tanino, resina, carbón tenemos que considerarlos como secundarios; en consecuencia hay que producir madera de calidad.

La madera es de mejor calidad cuando mejor satisface las exigencias del mercado, es decir, cuando mejor cubre las necesidades humanas. De esto podemos deducir que la calidad es muy relativa pues todo depende del aprovechamiento a que se destine la madera. Pues puede ocurrir que para un fin determinado la madera sea de primera calidad, mientras que para otro es inaprovechable. Así por ejemplo. la madera atacada por los hongos no es apta para fines técnicos, mientras que es muy apreciada para fines decorativos. La calidad de la madera puede ser interpretada de diferentes maneras, lo que hace posible que un silvicultor, con conocimientos sobre el aprovechamiento de la madera, puede encontrar para sus productos mercado favorable.

Sin embargo, generalmente designamos de primera calidad a la madera cuyas características físicas y mecánicas satisfacen las exigencias técnicas de la madera. Estas características están en estrecha relación con la estructura de sus tejidos. Las propiedades técnicas son exteriores e interiores. Las exteriores son aquellas que pueden ser observadas mediante los sentidos, como el color, el brillo, las vetas, el olor, etc. Las interiores se pueden determinar únicamente mediante ensayos, como el peso, la dureza, la elasticidad, la durabilidad, la flexibilidad, el hendimiento, la conductibilidad, etc.

Las caractersíticas técnicas de la madera están ligadas por su contenido de humedad y nudosidad. Desde el punto de vista de utilización de la madera, sin embargo, hay una notable diferencia. Por una parte el contenido de humedad, durante el crecimiento del árbol, no puede ser regulado y en el aprovechamiento industrial ésta no es necesaria, pues después del volteo dicho contenido de humedad puede ser modificado, según las necesidades de la industria, mediante secamiento natural o artificial.

Pero la nudosidad no puede ser modificada con posterioridad, por lo tanto, el silvicultor se ve obligado a criar árboles con la menor canti-

dad posible de nudos, si desea producir madera de buena calidad y de alto valor comercial.

Veamos pues ahora, que relación hay entre la nudosidad y la calidad de la madera y después trataremos la técnica con que el silvicultor puede disminuir la nudosidad de la madera.

LA RELACION ENTRE LA NUDOSIDAD Y LA CALIDAD

Los nudos son el encuentro y adherencia de los tejidos de las ramas con el tejido del tronco.

El crecimiento diametral de la madera se verifica por medio de capas anuales. Estas capas reciben el nombre de anillos de crecimiento. Generalmente los tejidos al comienzo de la vegetación son más blandos que al término de la misma. Los primeros son llamados tejidos primaverales y los segundos, tejidos de otoño. Las propiedades físicas y mecánicas de la madera dependen de la relación de estas dos clases de tejidos. Si dominan los tejidos de otoño, la madera es más densa, y desde el punto de vista de su utilización mecánica tiene excelente propiedades.

Los tejidos de las ramas son mucho más densos que los del tronco, pues los anillos de crecimiento debido al diámetro relativamente pequeño, se encuentran más estrechos y además tienen relativamente más tejidos de otoño que de primavera. Por esta razón los tejidos de las ramas, o sea los nudos son siempre más oscuros, más duros y completamente diferentes a los tejidos del tronco.

Desde el punto de vista de la utilización de la madera o sea mecánica y químicamente, los nudos son considerados como defectos pues influyen en las propiedades físicas y mecánicas de la misma. Prácticamente no hay propiedad en que no influya la presencia del nudo. Así se comprenderá el por qué en la clasificación se desvalorizan las maderas nudosas.

Hay estrecha relación entre la edad de los árboles y la nudosidad de la madera. Generalmente cuanto más joven sea el árbol más nudoso es. La mayoría de estos nudos son nudos vivos. Cuanto más edad tiene un árbol tanto más nudos muertos tendrá. Escte es el motivo por el cual la mayoría de los árboles viejos son enfermos y atacados por hongos e insectos, pues los nudos muertos facilitan la penetración de estos destructores.

Desde el punto de vista cualitativo distinguimos dos clases de nudos. Los nudos vivos y los nudos muertos.

Los nudos vivos provienen de yemas durmientes y ramas vivas y se caracterizan por estar adherido a los haces fibrosos de su contorno. El tejido adherido es completamente sano y solamente es irregular la formación de los anillos. Las propiedades físicas y mecánicas teóricamente, son iguales a las de los demás tejidos.

Los nudos muertos, al contrario, proceden de ramas muertas y no están adheridos con los haces fibrosos de la madera y se encuentran dentro del tejido de la misma como un cuerpo de ajeno, como una especie de clavo que no tiene ninguna relación con su alrededor. Por ésto se llama nudo muerto o clavo. El color del nudo muerto es diferente al de la madera, lo mismo que sucede con sus propiedades físicas y mecánicas. Por consiguiente modifica las propiedades de la madera y disminuye su valor. A veces la presencia de nudos muertos perjudica seriamente el valor comercial de la madera, pues la hacen inútil para la elaboración. Este es el motivo por el cual el silvicultor debe tomar todas las precauciones posibles para evitar la formación de nudos muertos.

Los nudos sean vivos o muertos, grandes o pequeños disminuyen en todo sentido la utilización de la madera. Su efecto no depende solamente del tipo del nudo, su tamaño, su cantidad, sino también de la posición que ocupa dentro de la madera. En otros casos las caracetrísticas mecánicas influyen de tal modo que en la construcción no se permite su presencia en la zona de tracción. Solamente puede existir en la zona comprimida.

La elevada dureza de los nudos, la desviación de las fibras a su alrededor no solamente dificultan la elaboración de la madera, sino que por la diferente estructura de sus tejidos

la madera reacciona de otra manera a las variaciones de la humedad y en consecuencia se mueve, o como se dice prácticamente, "trabaja" de un modo distinto que a su alrededor, tendiendo a separarse de su contorno por medio de las llamadas grietas de secamiento. Esta característica es mirada con poco agrado en la ebanistería y ésta es la causa por la cual no se permite la presencia de nudos en los trabajos delicados y solamente se admiten nudos vivos de pequeño diámetro y en cantidades muy bajas. Por ejemplo, sólo se permiten nudos vivos de hasta 14 mm de diámetro y únicamente dos por metro cuadrado.

De lo anteriormente dicho se comprenderá que los nudos muertos se caen de la madera durante la elaboración o un tiempo después de ello. Esta circunstancia obliga al carpintero a recortar no solamente el nudo, sino también su alrededor para reemplazarlo con un pedazo de madera nueva que servirá de tapa. Estas correcciones naturalmente, elevan el costo de la elaboración, pues exigen mucho tiempo, material y mano de obra. Por lo tanto, es lógico que la carpintería fina evite el empleo de maderas nudosas lo que implica la disminución de su valor comercial.

Lo mismo ocurre con las maderas nudosas en la fabricación de terciado, pues el recorte y el reemplazo de los nudos exigen maquinarias especiales de alto costo, sin contar la pérdida de tiempo, material y mano de obra. Las láminas nudosas aunque reparadas, únicamente pueden colocarse en el interior del terciado; es lo que llamamos vulgarmente placas ciegas.

Los nudos influyen considerablemente sobre la resistencia de la madera pues la disminuyen considerablemente.

Las exigencias contra la nudosidad crecen cuanto más valiosos y delicados productos deseamos fabricar. Así por ejemplo, láminas para chapas, instrumentos musicales, artículos de deportes, partes de avión y maquinarias, no permiten ningún nudo; lo mismo sucede con los artículos que requieren ser doblados y las hormas y otros artículos fabricados en el torno

Hasta la elaboración química de la madera es muy exigente contra la nudosidad. Por ejemplo, en la fabricación de papel son muy molestos los nudos y es por ésto que en la clasificación de los palos para la celulosa se toma en cuenta la nudosidad.

Solo excepcionalmente pueden valorizar los nudos a la madera. Un ejemplo típico de ello lo tenemos en la madera para decoraciones. Entre las maderas chilenas son muy apreciados los nuditos del pino araucaria.

Para otros fines se permiten solamente determinadas cantidades y distribución de los nudos, como en las construcciones en las minas, los postes, en los durmientes, etc. En éstos últimos no se permiten nudos en la zona comprimida.

Por los rollizos sin nudos se pagan precios especialmente altos, como sucede en Europa con los rollizos de roble y de abedul que se usan en la fabricación de láminas. Por lo general la práctica demuestra que el valor del rollizo sin nudos aumenta el 40 al 100 por ciento el volor de la madera.

De lo anteriormente expuesto se deduce que todas las normas de clasificación fijan las clases de nudos, el diámetro máximo permitido y la distancia del uno al otro.

En las normas de clasificación para las maderas de exportación vigentes en Chile, se agrupan los nudos de la siguiente manera: a) nudos firmes, b) nudos sueltos y c) racimos de nudos. Los nudos firmes son idénticos a los nudos vivos y los nudos sueltos a los muertos, lo que ya hemos tratado anteriormente. Los racimos de nudos están formados por varios nudos, alrededor de los cuales las fibras de la madera hacen desviaciones e irregularidades.

El citado reglamento determina el tamaño de los nudos para cada clase de madera y para cada especie. Así, en la primera clase de alerce, laurel, lingue, raulí, olivillo y tepa se permiten hasta 3 nudos firmes de no más de 1/2 pulgada de diámetro con una separación mínima de 20 pulgadas entre dos nudos.

Clasificando los nudos según su tamaño, podemos agruparlos en los siguientes cinco grupos: nudos pequeñísimos, cuyo diámetro es menor de cinco milímetros; pequeños entre 5 a 14 milímetros, medianos entre 15 a 34 milímetros, grandes entre 35 a 45 milímetros y muy grandes superiores a 45 milímemetros. El tamaño del nudo se determina en milímetros sobre la cara visible. Si el nudo no es redondo se toma siempre el diámetro mayor. Sin embargo, las normas alemanas (DIN No. 52181) toman el nudo por el diámetro menor. Cuando los nudos están dentro de la madera rodeados con cáscara reciben el nombre de "entrecasco", su diámetro se mide junto con la corteza. En los racimos de nudos se toman en cuenta las sumas de los diámetros menores en una distancia de 15 centímetros.

PODA DE LOS ARBOLES COMO FACTOR PRINCIPAL EN LA PRODUCCION DE MADERAS DE CALIDAD

De todo lo mencionado anteriormente se puede afirmar que una empresa forestal generalmente tiene el fin de producir económicamente madera de calidad en gran escala en breve tiempo. Estas condiciones básicas tienen hoy especial importancia pues las exigencias modernas son cada día mayores con respecto a la madera. Por lo tanto, el silvicultor deberá procurar de satisfacer estas exigencias en el más alto grado posible.

La técnica silvícola moderna ofrece muchas posibilidades para la silvicultura en la realización de esta tarea, pero la que nos interesa es la poda como un factor principal en la producción de madera de calidad.

Como sabemos, las ramificaciones son yemas desarrolladas del tallo, en nuestro caso, el tronco del árbol. Estas pueden ser laterales y terminales.

En la ramificación lateral la yema terminal del eje del tronco persiste, por lo que el eje se prolonga emitiendo a su alrededor ramas laterales cuyo grosor y longitud disminuyen regularmente de la base a la punta. El conjunto de esta ramificación da al árbol un aspecto cónico y muy característico. A este tipo de ramificación se da el nombre de monopodial y es característico en las coníferas, como son el alerce, el ciprés, el mañío, etc.

En la ramificación terminal la yema terminal se seca por lo cual el tallo no crece más longitudinalmente, desarrollándose las yemas axilares originando una ramificación que recibe el nombre de simpodial. En ésto no se puede distinguir el tronco como eje principal del árbol y las ramas fundamentales que lo reemplazan son aproximadamente del mismo grosor y nacen al mismo nivel. Estos tipos de ramificaciones los encontramos principalmente en las dicotiledonias como el algarrobo, el coigüe y otros.

Las ramas de las ramificaciones monopodiales son siempre más chicas y más delgadas que las ramas simpodiales. Debido a esta causa, las comíferas producen troncos bien rectos, cilíndricos y largos, con tejidos muy uniformes y con nudos pequeños.

Por el contrario, los troncos de los árboles con ramificaciones simpodiales son cortos, generalmente irregulares y con nudos grandes. Los tejidos son también de formación irregular, con muchas desviaciones causadas por las ramas grandes. La calidad de la madera obtenida de estos árboles es generalmente inferior a la de las coníferas.

Como los nudos son la unión de las ramas con el tronco del árbol, tanto su lugar, su forma como su tamaño son determinados por las ramas y por lo tanto pueden ser espirales o alternados en los árboles de hojas caducas y verticilados en las especies de coníferas.

En el desarrollo y vida de las ramas influyen muchos factores, de los cuales nos interesa únicamente el que se refiere a si los árboles crecen solitarios o en grupos.

Los árboles solitarios tienen abundantes ramificaciones, las ramas muy desarrolladas y en consecuencia su diámetro es siempre más grande que el de los árboles que crecen en grupos. En el otro caso, cuando los árboles crecen en espesuras, las ramas inferio-

res no se desarrollan, su diámetro es siempre pequeño y en consecuencia producen nudos pequeños e insignificantes. Naturalmente que los cortes efectuados a las ramas delgadas se cicatrizan más rápidamente y con mayor facilidad que los de las ramas gruesas. Los cortes efectuados a éstas últimas se cicatrizan difícilmente y por su gran demora son muy peligrosos, pues constituyen un foco de putrefacción.

Mientras las ramas están vivas no hay peligro, pues por una parte los tejidos del tronco y de las ramas constituyen nudos vivos que pueden producirse sin ninguna infección. Pero en cuanto se muere la rama por cualquiera circunstancia, el tejido del tronco no continúa en la rama sino que la rodea y de esta manera se forma el nudo muerto. Las ramas muertas empiezan a podrirse y llevan la putrefacción al tejido vivo del árbol. La producción de la madera de calidad exige cosechar árboles con la menor cantidad posible de nudos. El silvicultor puede obtener ésto criando árboles en masa y alejando las ramas sobrantes del tronco. El alejamiento de las ramas puede verificarse por método natural o artificial. El primero se denomina poda natural y el último poda, o para diferenciarlo del anterior, poda artificial.

La poda artificial se obtiene graduando, según las necesidades, la espesura del bosque por intermedio del raleo. Porque si los árboles viven en espesura cerrada, la luz y el sol llegan únicamente a aquellas ramas altas y las inferiores por falta de luz y sol van muriéndose y el árbol se despoja de ellas paulatinamente.

Sin embargo, los árboles se libran con gran dificultad y lentitud de las ramas muertas sobrantes, debido a que las ramas muertas deben ser atacadas por hongos para ser destruídas de tal modo que lleguen a romperse por su propio peso o por acción de los factores naturales, hasta que su lugar se cicatrice.

Este proceso requiere mucho tiempo pues para que los hongos puedan penetrar hasta los tejidos de las ramas, éstos deben ser primeramente perforados por insectos o rajaduras por secamiento. El desarrollo posterior de los hongos depende de las circunstancias que hayan encontrado. Si éstas son óptimas, la destrucción es rápida. La naturaleza pone sin embargo numerosos obstáculos a la rápida acción de los hongos, entre los cuales debemos mencionar en el primer lugar la variación continua del contenido de humedad de las ramas, lo que constituye el factor principal en el desarrollo de los hongos. Si la humedad de las ramas baja o sube en cierto límite, los hongos terminan sus actividades. Además los diferentes materiales, como el bálsamo, el tanino y otros, que se encuentran acumulados en las ramas, dificultan también la destrucción.

Cabe destacar que según las investigaciones referentes, cuando una rama, por falta de luz y sol pierde su normal equilibrio biológico, el árbol mismo por medio de su zona generatriz aisla interiormente la rama del tronco, apresurando de esta manera su muerte.

Las ramas destruídas por hongos se rompen por pedazos, desde su extremo hacia el tronco. Esta separación natural de las ramas del tronco exige mucho tiempo. Los experimentos nos demuestran que la separación natural de las ramas de haya de 1 centímetro de grosor, requiere tres a 6 años, de 3 centímetos de espesor 4 a 9 años y de 6 centímetros de 7 a 17 años. La poda de pinos "spruce" requiere mucho más tiempo, entre 30 a 90 años. El motivo de este largo período se encuentra en el contenido del bálsamo que, como ya hemos dicho, dificulta la acción de los hongos. La poda natural se verifica de abajo hacia arriba cuyo motivo es que el grosor de las ramas en las coníferas aumenta de abajo hacia arriba.

Por lo tanto, la poda natural es un proceso sumamente lento, cuya consecuencia natural es el aumento de la nudosidad de la madera. Un gran inconveniente de la poda natural es que después de la separación natural de las ramas del tronco siempre quedan bastantes pedazos adheridos al tronco, que el árbol solamente después de tanto tiempo puede cica-

trizar. Este hecho, además de ser un foco de infección, da origen a nudos muertos, los cuales descalifican y muchas veces inutilizan completamente la madera.

Podemos deducir que la poda natural no satisface completamente las exigencias de una producción de calidad, por lo cual debemos completarla con la poda artificial. Bajo ésto entendemos el alejamiento de las ramas sobrantes del tronco con diferentes herramientas.

Se puede clasificar la poda artificial, según sus fines, en poda de aprovechamiento y poda de educación. El primero, como ya su nombre indica, tiene por fin principal servir al aprovechamiento del bosque, como son los bosques económicos, las ramas forrajeras, las ramas de lecho, las ramas decorativas, etc. La poda de educación tiene por objeto producir madera de calidad, cuya propiedad mecánica satisface en el más alto grado posible las necesidades de la humanidad.

Dentro de la poda de educación distinguimos dos tipos: la poda verde y la poda seca. En el primer caso cortamos las ramas verdes y en el segundo las ramas secas. El efecto de estas dos clases de poda es muy diferente, por consecuencia el silvicultor debe tener gran cuidado en este aspecto. La poda seca, es decir por una parte impedimos el avance de la infección mediante la putrefacción de esa rama, por otra parte hacemos posible que el árbol pueda cicatrizar rápidamente su lugar y de esta manera se evita la propagación de nudos muertos.

El problema de la poda verde es más complejo. Su empleo correcto exige profundo conocimiento y el estudio de las circunstancias locales. Con un empleo incorrecto podemos ocasionar grandes daños. Sólo puede utilizarse con precaución. Principalmente debemos tener cuidado en el alejamiento de las ramas gruesas. Generalmente hay que tratar de evitar la disminución exagerada de la superficie asimiladora del árbol, además la superficie total de los cortes a cicatrizar no debe pasar cierto límite, por una parte para la rápida cicatrización, por otra parte, para evitar el desequilibrio de la vida biológica del árbol. Pues es natural que siendo la superficie de los cortes grandes, el árbol no puede generar su tejido antes de que los hongos lo hayan atacado. Si el proceso de la cicatrización ocupa demasiada energía, cesa el crecimiento del árbol, especialmente si junto a ello hemos disminuído demasiado la superficie de la copa. No necesito dar mayores explicaciones, pues ustedes comprenderán de todo lo anteriormente expuesto, que la poda verde en este caso es dañina.

El fin de la poda verde es la educación individual del árbol para aumentar su adaptabilidad técnica, es decir, la disminución de su nudosidad, la regularización de la forma del tronco, el aumento de su longitud, etc., etc. Este tipo de poda mejora también la uniformidad de los tejidos del tronco del árbol y su cilindricidad, pues modifica la formación natural de los anillos de crecimiento debido a que éstos serán más anchos en la parte superior del tronco y más angostos en la parte inferior. En consecuencia, el tronco toma una forma cilíndrica bastante uniforme en toda su longitud, lo que aumenta su valor comercial.

La poda verde disminuye en cualquier modo la superficie asimiladora de la copa, en consecuencia disminuye el crecimiento en longitud y espesor del árbol. La medida de esta disminución varía según la especie, la edad y las circunstancias locales. Es decir, en cuanto en mejores condiciones crece el árbol, tanto con mayor facilidad y rapidez cicatrizan las heridas originadas por la poda. Es natural que los árboles jóvenes cicatrizan con más facilidad que los viejos.

La poda verde de los árboles viejos es por lo general inconveniente. Puesto que estos árboles no pueden cicatrizar heridas o solamente durante largo tiempo, dan oportunidad para la acción de los hongos. Se comprende pues, que el efecto de la poda verde puede ser tan diferente, que podas realizadas de la misma manera, pueden dar efectos totalmente diferentes. El efecto de la poda verde depende mucho del método de su realización,

es decir, el corte, las herramientas empleadas, el tratamiento de los cortes, la época de la poda y su tamaño.

El corte de las ramas puede efectuarse de dos maneras. Cortando las ramas inmediatamente al lado del tronco, o en caso especial a mayor distancia de éste a fin de impedir el engrosamiento de la rama. El corte de las ramas inmediatamente al tronco puede realizarse ya sea paralelamente al tronco o perpendicularmente al eje de la rama. Generalmente el primero es más correcto. A pesar de que la superficie del corte en este caso es más grande, pero el árbol la cicatriza más rápidamente ya que la superficie cortada queda en nivel de los tejidos generatrices del tronco. En este caso naturalmente el nudo será menor.

El corte efectuado perpendicularmente al eje de la rama se cicatriza con lentitud, ocasionando nudos muertos, grandes y que por el mismo motivo muestran a menudo señales de infección. Desde el punto de vista cualitativo de la madera, este caso es siempre inconveniente. Sin embargo, pueden presentarse casos, como en el corte de ramas grandes, cuando la superficie del corte paralelo al tronco sería tan grande que éste no puede regenerarlo y en consecuencia es más ventajoso el corte perpendicular al eje de la rama.

La mutilación de la rama no es aconsejable. En casos excepcionales puede permitirse, como cuando se trata de dar espacio para los renovales al lado del árbol grande, mutilando algunas de sus ramas. Pero sólo puede permitirse si el árbol será volteado dentro de poco tiempo.

El efecto de la poda depende también de la herramienta empleada. La condición previa para una cicatrización rápida es que la superficie del corte sea lo más lisa posible. Toda rajadura, barba de fibras, pedazos de cáscara, etc., dificultan la cicatrización. Para evitar ésto debemos utilizar herramientas con bastante filo tales como machetes u otros tipos de cuchillos especiales que sólo podrán emplearse en caso de ramas delgadas. El corte de las ramas más gruesas deberá realizarse siempre con serruchos (manual, con mango largo o circulares especiales) pues únicamente con ésto se puede cortar las ramas sin que se produzcan rajaduras. Para estos fines existen serruchos especiales que tienen pequeños dientes continuos triangulares oblícuos o parados. Estos dientes están fabricados para trabajar de tiraje o empuje. Los serruchos de mango largo generalmente trabajan tirando.

Otro factor que influye en el resultado de la poda es la técnica empleada en el corte. Ramas gruesas deben cortarse por pedazos, del extremo hacia el tronco. Al llegar al último pedazo antes de efectuar el corte hay que practicar una incisión en la parte inferior de la rama y si es necesario introducimos además una cuña. Si se trata de superficies de corte extremadamente grande, en otoño, es recomendable cubrirla con una capa de cera. En ramas de coníferas no es necesario.

Es sumamente importante que la poda sea efectuada por obreros especialistas. A las ramas inferiores las cortamos desde la tierra con serruchos manuales; ramas más altas, de 10 a 12 metros se cortan con serruchos de mango largo. Las ramas situadas aún más arriba las cortamos también con serrucho.

La época de la poda tiene especial importancia en su efecto. Generalmente la época más propicia para efectuarla es el fin del invierno o el principio de la primavera, cuando las heridas, los cambios de clima, como el frío y el calor, no pueden dañarla y cuando la corteza está aun adherida al tronco. Algunas personas opinan que la mejor época para la poda es el comienzo de la circulación de la savia, pues la cicatrización de las heridas comienza enseguida, pero tiene por defecto el que en esta época, por la circulación de la savia, son inevitables los desprendimientos de corteza y las rajaduras en el tronco.

Es muy difícil determinar la medida de la poda, el diámetro de las ramas a cortarse y su cantidad, además su distribución en el tronco. Solamente especialistas con práctica pueden determinar la superficie herida que

determinadas especies, en distintas edades y circunstancias, pueden soportar y el efecto que va a producirse en la calidad de la madera. Como ya sabemos, una mala poda tiene graves consecuencias en el incremento y en la calidad de la producción.

Así mismo es también un problema muy importante determinar la economía de la poda. Pero es muy difícil encontrar el límite económico de ella, o sea, cuando los gastos de la poda son recompensados por la calidad de la madera. El silvicultor con práctica sabe muy bien que la poda es un trabajo bastante costoso y su ejecución mayormente se restringe o anula por causas económicas, como se hace actualmente con las plantaciones de pino insigne en Chile.

Como regla general podemos decir que la poda seca en cualquier circunstancia es siempre económica, pues los nudos muertos desvalorizan la madera. La poda verde requiere ya muchas precauciones. Pero la poda educativa siempre se recompensa con sus efectos, por lo tanto, hay que tratar de ejecutarla. Podemos economizar mucho en la poda usando podadores mecánicos como el motomachete por ejemplo, que en una mano experta tiene un alto rendimiento y así su uso es muy económico. Su precio se recompensa siempre con su rendimiento.

Debo mencionar todavía que en la cicatrización de las heridas por el árbol, no hay diferencia entre la poda verde y la poda seca. Pero es muy importante saber que los tejidos de la cicatrización se pueden unir con los tejidos muertos de la herida. La cicatrización solamente recubre fuertemente la superficie del corte, dejando una capa de celulosa muerta dentro del tejido del tronco. Esta capa es tanto más gruesa cuanto más lenta haya sido la cicatrización. Si la cicatrización se efectúa después que los hongos han infectado esta parte, generalmente continúa su destrucción, aún después de haber sido encerados.

Los tejidos de la cicatrización pueden ser de dos orígenes: tejidos de la zona generatriz del tronco y tejido del cambium de las ramas. La cicatrización se efectúa de afuera hacia adentro, pero no con la misma rapidez. Los lados se cicatrizan más rápidamente que las partes superior e inferior, y de la parte superior a la inferior más rápidamente que de la parte inferior a la superior. Esta es la causa por la cual las heridas quedan abiertas más tiempo en la parte inferior. En heridas grandes la parte inferior queda descubierta durante muchos años. En estos lugares es muy característico ver una emanación negruzca, que no es más que los materiales de la corteza y albura lavados (tanino, etc.) por el agua que luego al evaporarse queda pegada a la corteza.

Desde el punto de vista práctico es muy importante la rapidez de la cicatrización. Cuanto más rápida es la cicatrización de las heridas, tanto menor es el peligro de infección de los tejidos del árbol. Es comprensible que la bruta superficie dejada por la poda natural se cicatriza lentamente y con mayor dificultad que la superficie lisa de la poda artificial. Es por ésto que también es necesaria la poda seca ya que acelera la rápida cicatrización del corte. Es también lógico que los cortes de poda verde se cicatrizan más rápidamente que las heridas de poda seca, pues en la poda verde el corte está en contacto inmediato con las células vivas de la zona generatriz, mientras que en el corte de la poda seca las células están más lejos, es decir, tienen que cicatrizar relativamente mayor superficie en ramos iguales. Como ya dijimos, las heridas causadas en la línea del tronco cicatrizan siempre más rápidamente que las situadas más afuera de él. Cualquier irregularidad dificulta la cicatrización. La superficie lisa o bruta no incluye en la rapidez de la cicatrización.

La poda educativa debe estar en estrecha relación con el raleo. Ninguna puede ser reemplazada por otra. El raleo es el medio de la educación de la masa. La poda como hemos visto, está destinada a asegurar la producción de madera de calidad. Por lo

tanto, ambas son indispensables para que el silvicultor pueda satisfacer las necesidades económicas de la empresa silvícola, es decir, la producción de maderas de calidad y en mayor cantidad.

RESUMEN

La silvicultura debe procurar producciones cualitativas, pues únicamente de esta manera podrá satisfacer las exigencias del mercado futuro y puede obtener más precio por sus productos.

La base de la producción cualitativa es producir maderas poco nudosas. La poca nudosidad se obtiene con la adecuada técnica de cultivo, raleo y poda natural y artificial.

Es muy difícil determinar la medida de la poda artificial. La poda seca se puede efectuar en todos los casos. El límite de la poda verde queda determinado por el conjunto de factores biológicos y económicos.

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